# Optoelectronics Designer's Catalog 1982

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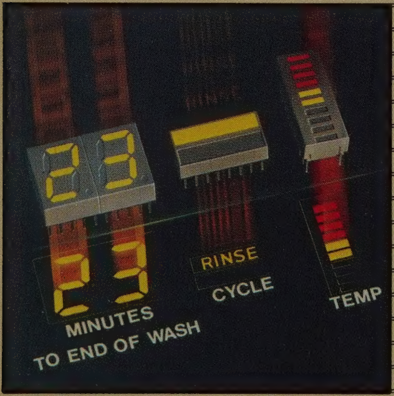
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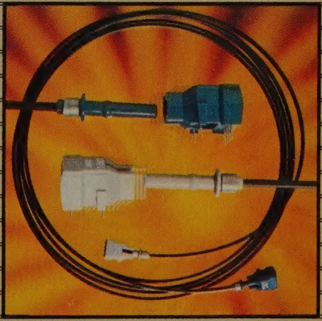

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# Optoelectronics Designer's Catalog 1982

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*Intensive solid state research, the development of advanced manufacturing techniques and continued expansion has enabled Hewlett-Packard to become a high volume supplier of quality, competitively priced LED displays, LED lamps, optocouplers, fiber optics, and emitters/detectors.*

*In addition to our broad product line, Hewlett-Packard also offers the following services: immediate delivery from any of our authorized stocking distributors, applications support, special QA testing, and a one year guarantee on most of our optoelectronic products.*

*This package of products and services has enabled Hewlett-Packard to become a recognized leader in the optoelectronic industry.*

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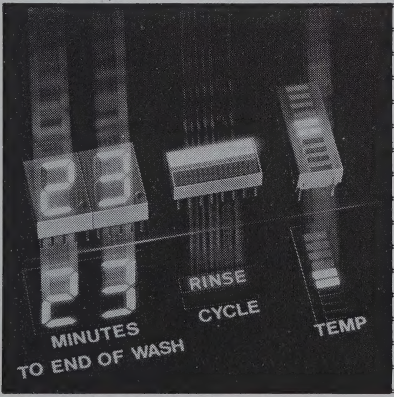

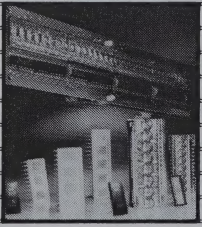

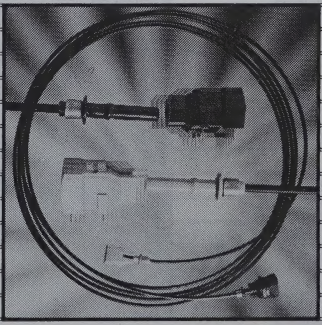

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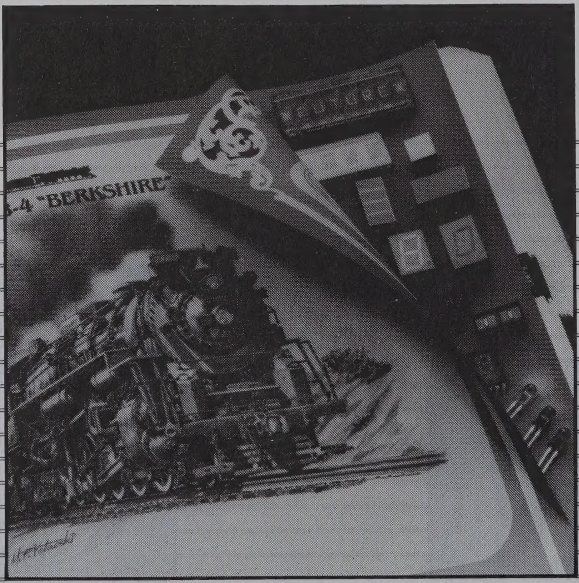

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New Products in **BOLD** Type.

# A Brief Sketch

*Hewlett-Packard is one of the world's leading designers and manufacturers of electronic, medical, analytical and computing instruments and systems, diodes, transistors, and optoelectronic products. Since its founding in Palo Alto, California, in 1939, HP has done its best to offer only products that represent significant technological advancements.*

*To maintain its leadership in instrument and component technology, Hewlett-Packard invests heavily in new product development. Research and development expenditures traditionally average about 10 percent of sales revenue, and over 1,500 engineers and scientists are assigned the responsibilities of carrying out the company's various R and D projects.*

*For the customer, Hewlett-Packard is no further away than the nearest telephone. Hewlett-Packard currently has sales and service offices located around the world.*

*These field offices are staffed by trained engineers, each of whom has the primary responsibility of providing technical assistance and data to customers. A vast communications network has been established to link each field office with the factories and with corporate offices. No matter what the product or the request, a customer can be accommodated by a single contact with the company.*

## Where Reputation and Quality Count

*When quality represents a competitive edge, or when the reputation and dependability of your products is on the line, you can count on Hewlett-Packard Optoelectronic components for excellent product consistency.*

*The optoelectronic products available include a complete line of GaAsP and GaP discrete light emitting diodes (LED's), numeric, hexadecimal, and alphanumeric displays, optocouplers, fiber optics, and emitters/detectors. For a general overview of the products available, the next eight pages will include highlights of the discrete product family groups. There is complete technical data included in this designer's catalog for each of the Hewlett-Packard Optoelectronics products.*

# About This Catalog

*This Optoelectronics Designer's Catalog contains detailed, up-to-date specifications on our complete optoelectronic product line. It is divided into seven major product sections: Light Bars and Bar Graphs, LED Lamps, LED Displays, Emitters/Detectors, Fiber Optics, Optocouplers, and High Reliability Products. A special section which includes abstracts of all of the application notes follows the High Reliability product section.*

## How to Use This Catalog

*Three methods are incorporated for locating components:*

- *a Table of Contents with tabs that allow you to locate components by their general description*
- *a Numeric Index that lists all components by part number and,*
- *a Selection Guide for each product group giving a brief overview of the product line.*

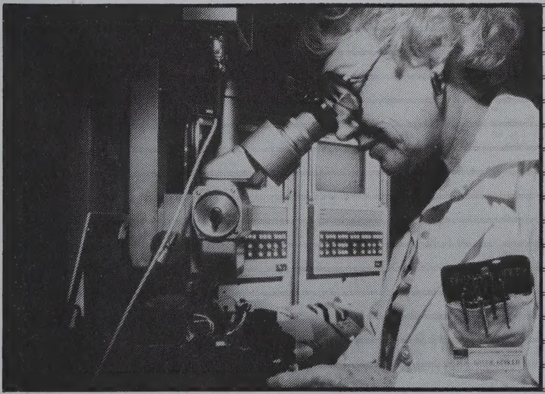
## How to Order

*All Hewlett-Packard components may be ordered through any of the Sales and Service Offices listed on pages 423-428. In addition, for immediate delivery of Hewlett-Packard optoelectronic components, contact any of the world-wide stocking distributors and representatives listed on pages 420-422.*

## Warranty

*HP's Components are warranted against defects in material and workmanship for a period of one year from the date of shipment (in the case of designated Fiber Optics and Bar Code products 90 days from the date of shipment). HP will repair or, at its option, replace Components that prove to be defective in material or workmanship under proper use during the warranty period. This warranty extends only to HP customers.*

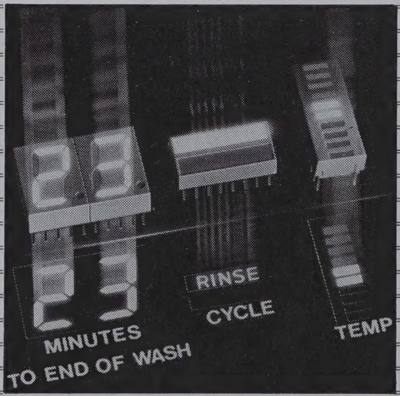
*No other warranties are expressed or implied, including but not limited to, the implied warranties or merchantability and fitness for a particular purpose. HP is not liable for consequential damages.*



# Light Bars and Bar Graph Arrays

*LED Light Bars are Hewlett-Packard's innovative solution to fixed message annunciation. The large, uniformly illuminated light emitting surface may be used for backlighting legends or simple indicators. Three distinct colors are offered, high efficiency red, yellow, and high performance green, with two bicolor combinations (see page 16). Each of the eight X-Y stackable package styles offers one, two, or four light emitting surfaces. Each device has a universal pinout arrangement allowing series, parallel, or series/parallel configurations. Panel and Legend Mounts are also available for all devices.*

*In addition to light bars, HP offers effective analog message annunciation with the new 10-element and 101-element LED Bar Graph Arrays. These bar graph arrays eliminate the matching and alignment problems commonly associated with discrete LED indicators. Each device offers easy to handle packages that are compatible with standard SIP and DIP sockets. The 10-Element Bar Graph Array is available in standard red, high efficiency red, and yellow. The package is X-Y stackable, with a unique interlock allowing easy end-to-end alignment. The 101-Element Bar Graph Array is offered in standard red with 1% resolution.*



# Solid State Displays

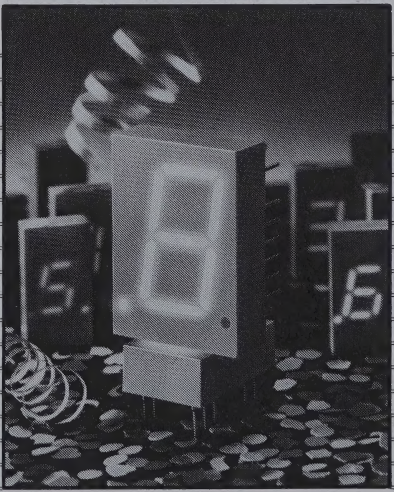
*Hewlett-Packard has expanded and improved its selection of both alphanumeric and seven segment numeric displays and continues to offer the convenience and reliability of integrated numeric and hexadecimal displays.*

*Hewlett-Packard's 5 x 7 dot matrix alphanumeric display line has been expanded to include two larger character sizes: 5.0mm (0.20 inch) and 6.9mm (0.27 inch). These larger character alphanumeric displays are ideal for applications requiring greater viewing distance or where general viewability needs to be enhanced.*

*These new larger alphanumeric as well as the compact 3.8mm (0.15 inch) display, are now available in yellow or high efficiency red, where additional performance is required. These displays are particularly suited to avionic, military, industrial control, and instrumentation applications.*

*We've also enhanced our line of seven segment numeric displays. The minimum brightness of these displays has been improved by 30% on average, which allows a user to operate the displays in brighter ambients or at lower power levels. The color spread on our yellow devices is now strictly limited by a minimum and maximum wavelength specification which insures that you get a yellow display. Our line of high ambient displays have had their minimum intensity specifications boosted 50%, and a new line of .56" high ambient displays with typical intensities of 7.0 mcd has been added. Hewlett-Packard's line of .3", .43", .56", and .8" displays in Red, High Efficiency Red, Yellow, and Green is now better able to meet your display needs for electronic instrumentation, point of sale equipment, appliances, and automotive instrumentation.*

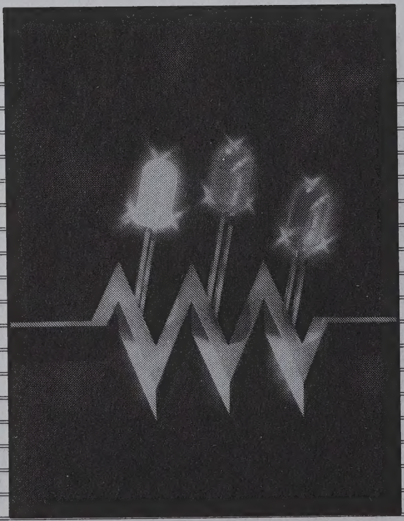
*Integrated numeric and hexadecimal displays (with on-board IC's) solve the designer's decoding/driving problem. They are available in plastic package for general purpose usage, ceramic/glass package for industrial applications, and hermetic packages for high reliability applications. This family of displays has been designed for ease of use in a wide range of environments.*



# Lamps

*Brightness and increased performance describe Hewlett-Packard's growing LED Lamp product line. This year several introductions, including that of the Ultra Bright family, feature higher intensity material. High Performance Green, High Brightness Yellow and High Efficiency Red all offer luminous intensities that have significantly increased, some more than doubling.*

*Hewlett-Packard's LED Lamps are available in a wide variety of P.C. board mountable plastic and hermetic packages to satisfy almost any application. Package styles include the traditional T-1 3/4 and T-1, high and low dome, as well as subminiature (single and tape and reel), rectangular, and panel mountable hermetic packages. Military screening procedures occur for all hermetic lamps.*



# Emitters/Detectors

*Hewlett-Packard enters the fast growing bar code entry market with the introduction of the HEDS-3000 and HEDS-3050 Digital Bar Code Wands. The HP Wand is designed to read black and white bar codes (and also most colors) with a 0.3mm (0.012 in) minimum bar width. It consists of a precision integrated optical sensor, amplification, and an analog to digital converter, and is fully compatible with TTL and CMOS circuitry.*

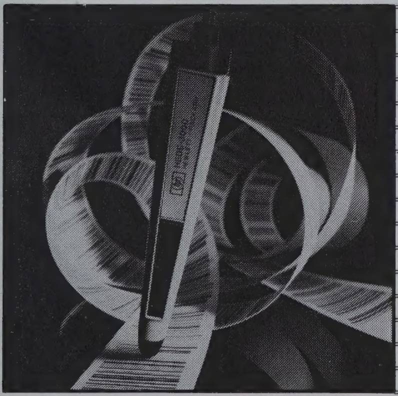
*For customers not wishing to invest in decoding technology, the HEDS-0100/-0150 bar code decoding module can be interfaced directly to the HP Wand, thus providing the designer with a complete data entry solution. Industry standard Code 3 of 9 input and a choice of standard output configuration make this bar code data entry package ideal for applications where extensive investment in bar code decoding technology cannot be justified.*

*The HEDS-1000 is a small, high resolution reflective sensor combining a light source and detector with focused optics in a single package. This unique component can detect an object as fine as a human hair as well as the precise edge of large objects such as paper or printed lines and marks. It is ideally suited in such applications as pattern recognition, optical limit switching, tachometry, defect detection, and bar code scanning.*

*A new, small (only 28mm diameter) two channel Optical Shaft Encoder, the HEDS-5000, has been recently introduced by Hewlett-Packard. This high resolution incremental optical encoder kit performs at 500 cycles/revolution, has an LSTTL compatible digital output, and is quick and easy to assemble.*

*Hewlett-Packard offers the designer a wide choice of discrete emitter and detector components. High radiant intensity emitters in the near infrared range are available in both floodlight and spotlight configurations.*

*Hewlett-Packard PIN photodiodes are excellent light detectors with an exceptionally fast response, wide spectral response, wide range linearity, and low dark current. High reliability test programs are also available.*



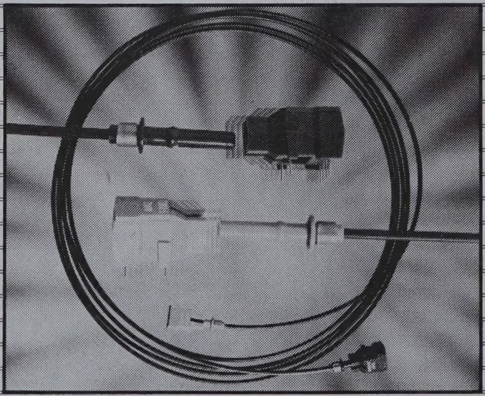
# Fiber Optics

*Hewlett-Packard provides a series of fiber optic components, RS-232-C/V.24 to fiber optic data communications equipment and fiber optic cable/connectors. The Snap-In Fiber Optic Link (HFBR-0500) series is a low-cost, short distance system which utilizes 1mm all plastic fiber optic cable and easy-to-install plastic snap-in connectors. The transmitter and receiver devices are packaged in dual-in-line configurations for easy PC board or socket installation. The Miniature Fiber Optic Logic Link (HFBR-0200) series, as well as the High Performance Metal Module Series (HFBR-1000/2000) are designed for use with 100/140$\mu$m clad silica fiber optic cable and precision metal connectors. The HFBR-0200 series transmitter and receiver are housed in miniature, lensed metal packages. HFBR-1000/2000 series High Performance Modules provide guaranteed performance at 10 mBaud up to 1000 metres. Evaluation kits containing transmitter, receiver, connectored fiber optic cable and technical literature are available for all three series.*

*The 39301A 16 channel RS-232-C/V.24 to fiber optic multiplexer is a new product for 1982. Use of this system will allow extension of up to 16 independent 19.2 kpbs full duplex channels to distances up to 1 km.*

*Fiber Optic Cables for these products are available, with or without factory installed connectors, in user specified lengths. Also, assembly instructions and necessary hardware are available for customers who prefer to attach connectors, or repair a fiber cable, in a field location.*

*The design of cost-effective fiber optic systems requires the understanding and analysis of several complex technologies — optical fibers, precision connectors, LED/laser emitters, photodetectors, circuit design, packaging and optics. Hewlett-Packard's approach to the design of fiber optic hardware is systems oriented, drawing on the broad base of technologies available within our computer, instrumentation, semiconductor components, and corporate research and development activities. State-of-the-art LED, photodetector, and integrated circuit capability are at the heart of Hewlett-Packard's fiber optic systems. Beginning on page 282 of this catalog, you will find further details on Hewlett-Packard's fiber optic systems.*



# Optocouplers

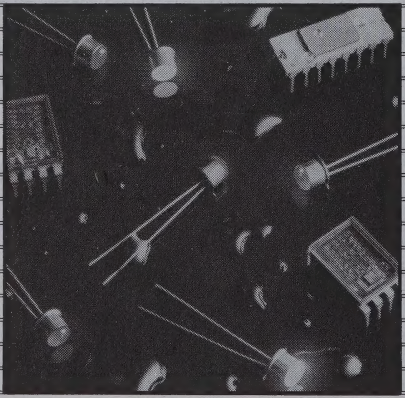
*Hewlett-Packard's family of optocouplers provide economical, high performance solutions to problems caused by ground loops and induced common mode noise for both analog and digital applications in commercial, industrial, and military products. Hewlett-Packard's original approach toward integrated output detectors provides performance not found in conventional phototransistor output optocouplers*

*Hewlett-Packard's newest optocoupler, the HCPL-3700, features an isolated AC/DC threshold-sensing input with a logic compatible output. This power to logic optocoupler is capable of sensing a predetermined threshold level by the appropriate selection of an external resistor. With 3000 DC isolation, other types of optocouplers available include high speed devices capable of 10M bits and high gain devices which are specified at 400% CTR at input currents as low as 0.5mA. In addition, highly linear optocouplers are useful in analog applications, and a Hewlett-Packard integrated input optically coupled line receiver can be connected directly to twisted pair wires without additional circuitry. Most of these devices are available in dual versions, as well as in hermetic DIP packages. For military users, Hewlett-Packard's established hi-rel capability facilitates economical, hi-rel purchases.*

# High Reliability

*Hewlett-Packard has supplied specially tested high reliability optoelectronic products since 1968 for use in state-of-the-art commercial, military, and aerospace applications. To meet the requirements of high reliability, products must be designed with rugged capabilities to withstand severe levels of environmental stress and exposure without failure. We have accomplished this objective by designing a unique family of hermetic products including lamps, displays and optocouplers which have proven their merits in numerous advanced space and defense programs to the international market place. These products receive reliability screening and qualification tests in accordance with appropriate reliability programs similar to those of MIL-S-19500 and MIL-M-38510 and are supplied as either standard JAN or JANTX devices or as HP standard high reliability units which meet our in-house TXV or TXVB programs. Reliability programs are also performed to individual customer control drawings and specifications when needed. Some of these special testing programs are very complex and may include Class S requirements for microcircuits. HP's optoelectronic epoxy encapsulated products are designed for long life applications where non man rated or ground support requirements allow their use. As with hermetic products, the capabilities of epoxy parts can be enhanced by 100% screening and conditioning tests. Lot capabilities can be confirmed by acceptance qualification test programs.*

*All testing is done by experienced Hewlett-Packard employees using facilities which are approved by DESC for JAN products and by customer inspection for special programs. Environmental equipment capabilities and operating methods of the test laboratory meet MIL-STD-750 or MIL-STD-883 procedures.*



# Applications

*The Optoelectronic Division Visible Products and Interface Products Applications Department has authored over 30 application notes and bulletins which present detailed electrical, optical, and mechanical design support for OED products. Abstracts of all these notes appear in the back of this catalog.*

*These notes and bulletins are available from your local HP Components Field Engineer, or may be obtained directly from Hewlett-Packard Inquiries Department, 1820 Embarcadero Road, Palo Alto, California, 94303.*

*For those desiring a complete coverage of LED optoelectronic technology a reference text entitled "Optoelectronics Application Manual, 2nd Ed. HPBK-2000", is available for purchase from McGraw Hill, or your local HP components stocking distributor.*

## Applications Support

*A staff of Visible Products applications engineers and a staff of Interface Products applications engineers are available to answer your technical questions on the operation and use of OED's optoelectronic components. They may be contacted in Palo Alto, CA during business hours of 8:30 AM to 5:00 PM, PST.*

*The Visible Products applictions engineers are available to answer your technical questions on the use and selection of visible optoelectronic components. These engineers are knowledgeable in the design of LED display and indicator interface circuitry, selection of contrast enhancement filters, measurement of intensity and dominant wavelength, and design factors for front panels.*

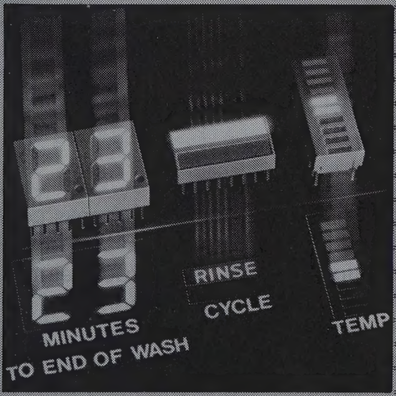
*The Interface Products applications engineers can provide design and specification assistance for optical fiber data communications components, electrical interfacing with optocouplers, PIN photodiodes and optical emitters, optical shaft encoding, high resolution optical sensors, and bar code systems.*

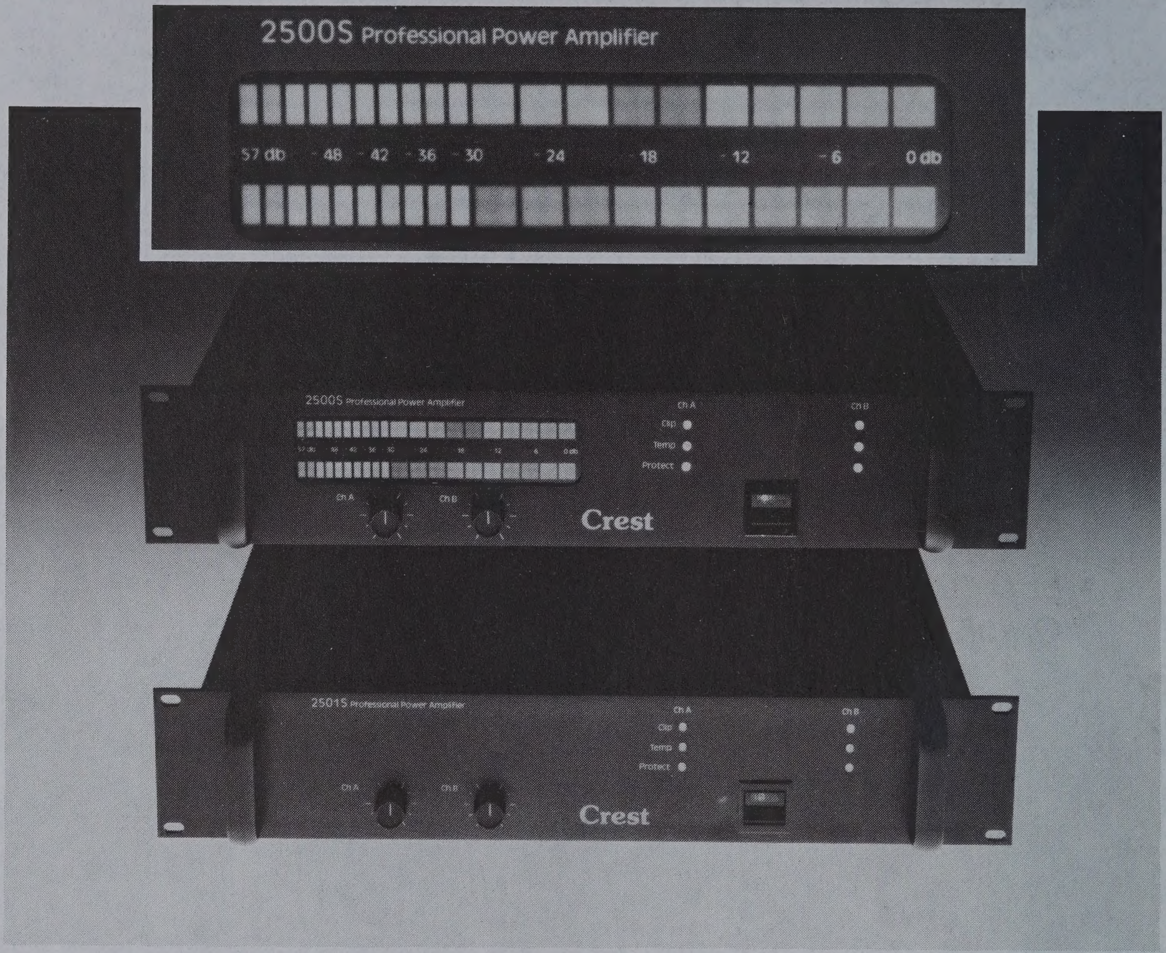
*For specific product applications support please contact your local HP Components Sales Office for reference to the appropriate engineer.*

OPTOELECTRONICS
FIBER-OPTICS APPLICATIONS MANUAL
2nd Edition
Hewlett-Packard
OPTOELECTRONICS

# Light Bars and Bar Graph Arrays

- *Product Selection Guide . . . . . . . . 2*
- *LED Light Bars — SIP*
- *LED Light Bars — DIP*
- *LED Bicolor Light Bars — DIP*
- *Panel and Legend Mounts for Light Bars*
- *LED 10-Element Bar Graph Array*
- *LED 101-Element Bar Graph Array*

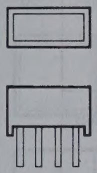
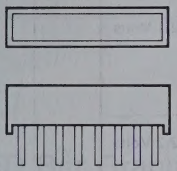
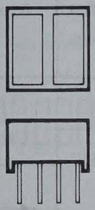
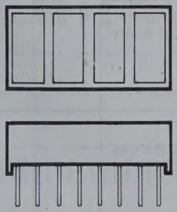

23
23
RINSE
CYCLE
TEMP
MINUTES
TO END OF WASH


2500S Professional Power Amplifier
57 db
-48
-42
-36
-30
-24
-18
-12
-6
0 db
Ch A
Ch B
Clip
Temp
Protect
Crest
2501S Professional Power Amplifier

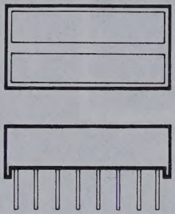
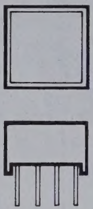
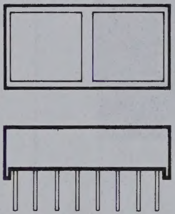
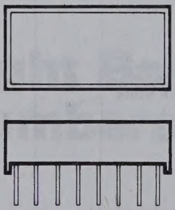
# Light Bars and Bar Graph Arrays Grow in Numbers and in Applications

Applications for Light Bars and Bar Graph Arrays are as varied as they are numbered. As demonstrated by the Crest amplifier shown above, several Light Bar packages may be end-stacked to perform the function of a mechanical VU meter with much more visual stimulation. Currently, Light Bars and Bar Graph Arrays are addressing the backlighting and indicator needs of the office/business machine industry, telecommunications industry, process control instrumentation industry, and even the transportation industry. The added feature of package compatibility between the 0.3" seven segment displays, Light Bars, and 10-Element Bar Graph Arrays have helped solve digital and analog information display requirements of complete front control panels.

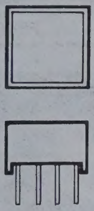
# LED Light Bars

| Device | | Description | | | Typical Luminous Intensity @ 20 mA | Typical Forward Voltage @ 20 mA | Page No. |
|---|---|---|---|---|---|---|---|
| **Package Outline Drawing** | **Part No.** | **Color** | **Package** | **Lens** | | | |
|  | HLMP-2300 | High Efficiency Red | 4 Pin In-Line; .100″ Centers; .400″L x .195″W x .240″H | Diffused | 10 mcd | 1.9 Volts | 6 |
| | HLMP-2400 | Yellow | | Diffused | 6 mcd | 2.0 Volts | |
| | HLMP-2500 | Green | | Green Diffused | 10 mcd | 2.1 Volts | |
|  | HLMP-2350 | High Efficiency Red | 8 Pin In-Line; .100″ Centers; .800″L x .195″W x .240″H | Diffused | 20 mcd | 1.9 Volts | |
| | HLMP-2450 | Yellow | | Diffused | 12 mcd | 2.0 Volts | |
| | HLMP-2550 | Green | | Green Diffused | 20 mcd | 2.1 Volts | |
|  | HLMP-2600 | High Efficiency Red | 8 Pin DIP; .100″ Centers; .400L x .400″W x .240″H; Dual Arrangement | Diffused | 10 mcd | | 10 |
| | HLMP-2700 | Yellow | | Diffused | 6 mcd | 2.2 Volts | |
| | HLMP-2800 | Green | | Green Diffused | 10 mcd | | |
|  | HLMP-2620 | High Efficiency Red | 16 Pin DIP; .100″ Centers; .800″L x .400″W x .240″H; Quad Arrangement | Diffused | 10 mcd | 2.1 Volts | |
| | HLMP-2720 | Yellow | | Diffused | 6 mcd | 2.2 Volts | |
| | HLMP-2820 | Green | | Green Diffused | 10 mcd | | |

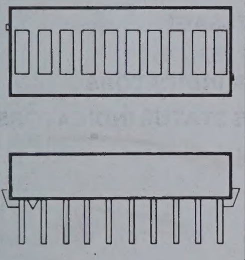
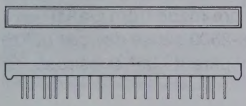
# LED Light Bars (Continued)

| Device | | Description | | | Typical Luminous Intensity @ 20 mA | Typical Forward Voltage @ 20 mA | Page No. |
|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color | Package | Lens | | | |
|  | HLMP-2635 | High Efficiency Red | 16 Pin DIP; .100″ Centers; .800″L x .400″W x .240″H; Dual Bar Arrangement | Diffused | 20 mcd | 2.1 Volts | 10 |
| | HLMP-2735 | Yellow | | Diffused | 12 mcd | 2.2 Volts | |
| | HLMP-2835 | Green | | Green Diffused | 20 mcd | | |
|  | HLMP-2655 | High Efficiency Red | 8 Pin DIP; .100″ Centers; .400″L x .400″W x .240″H; Square Arrangement | Diffused | 20 mcd | 2.1 Volts | |
| | HLMP-2755 | Yellow | | Diffused | 12 mcd | 2.2 Volts | |
| | HLMP-2855 | Green | | Green Diffused | 20 mcd | | |
|  | HLMP-2670 | High Efficiency Red | 16 Pin DIP; .100″ Centers; .800″L x .400″W x .240″H; Dual Square Arrangement | Diffused | 20 mcd | 2.1 Volts | |
| | HLMP-2770 | Yellow | | Diffused | 12 mcd | 2.2 Volts | |
| | HLMP-2870 | Green | | Green Diffused | 20 mcd | | |
|  | HLMP-2685 | High Efficiency Red | 16 Pin DIP; .100″ Centers; .800″L x .400″W x .240″H; Single Bar Arrangement | Diffused | 40 mcd | 2.1 Volts | |
| | HLMP-2785 | Yellow | | Diffused | 24 mcd | 2.2 Volts | |
| | HLMP-2885 | Green | | Green Diffused | 40 mcd | | |

# LED Bicolor Light Bars

| Device | | Description | | | Typical Luminous Intensity @ 20 mA DC | Typical Forward Voltage @ 20 mA | Page No. |
|---|---|---|---|---|---|---|---|
| **Package Outline Drawing** | **Part No.** | **Color** | **Package** | **Lens** | | | |
|  | HLMP-2950 | High Efficiency Red/ Yellow | 8 Pin DIP; .100" Centers; .400"L x .400"W x .240"H; Square Arrangement. | Diffused | HER: 20 mcd<br>Yellow: 12 mcd | HER: 2.1 V<br>Yellow: 2.2V | 16 |
| | HLMP-2965 | High Efficiency Red/ Green | | Diffused | HER: 20 mcd<br>Green: 20 mcd | HER: 2.1V<br>Green: 2.2V | |

# LED Bar Graph Arrays

| Device | | Description | | | Typical Luminous Intensity | Typical Forward Voltage | Page No. |
|---|---|---|---|---|---|---|---|
| **Package Outline Drawing** | **Part No.** | **Color** | **Package** | **Lens** | | | |
|  | HDSP-4820 | Standard Red | 20 Pin DIP; .100" Centers; 1.0" L x .400" W x .240" H | Diffused | 880 μcd @ 20mA DC | 1.6V @ 20mA DC | 24 |
| | HDSP-4830 | High Efficiency Red | | Diffused | 1700 μcd @ 10 mA DC | 2.1V @ 20mA DC | |
| | HDSP-4840 | Yellow | | Diffused | 1200 μcd @ 10mA DC | 2.2V @ 20mA DC | |
|  | HDSP-8820 | Standard Red | 22 Pin SIP; .100" Centers; 4.16"L x .390"W x.236"H | Red, Non-Diffused | 20 μcd @ 100mA Pk: 1 of 110 D.F. | 1.7V @ 100mA Pk: 1 of 110 D.F. | 30 |

**HEWLETT PACKARD**

# LED LIGHT BARS

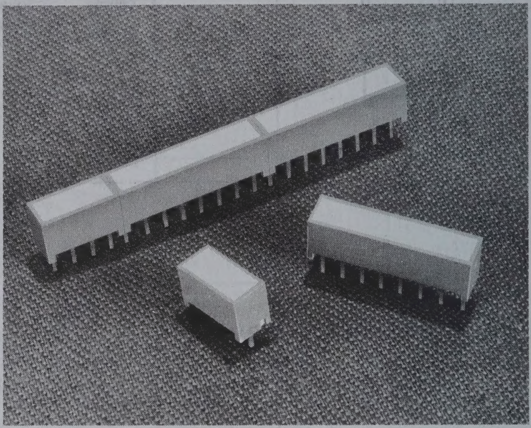
## SIP — Single Light Emitting Area

### HIGH EFFICIENCY RED HLMP-2300 SERIES
### YELLOW HLMP-2400 SERIES
### HIGH PERFORMANCE GREEN HLMP-2500 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- LARGE, BRIGHT, UNIFORM LIGHT EMITTING AREA
  Approximately Lambertian Radiation Pattern
- CHOICE OF THREE COLORS
- CATEGORIZED FOR LIGHT OUTPUT
- YELLOW AND GREEN CATEGORIZED FOR DOMINANT WAVELENGTH
- EXCELLENT ON-OFF CONTRAST
- EASILY MOUNTED ON P.C. BOARDS OR SIP SOCKETS
- MECHANICALLY RUGGED
- X-Y STACKABLE
- FLUSH MOUNTABLE
- CAN BE USED WITH PANEL AND LEGEND MOUNTS
- LIGHT EMITTING SURFACE SUITABLE FOR LEGEND ATTACHMENT PER APPLICATION NOTE 1012
- SUITABLE FOR MULTIPLEX OPERATION
- I.C. COMPATIBLE



## Applications

- BUSINESS MACHINE MESSAGE ANNUNCIATORS
- TELECOMMUNICATIONS INDICATORS
- FRONT PANEL PROCESS STATUS INDICATORS
- PC BOARD IDENTIFIERS
- BAR GRAPHS

## Description

The HLMP-2300/-2400/-2500 series light bars are rectangular light sources designed for a variety of applications where a large, bright source of light is required. These light bars are configured in single-in-line packages that contain a single light emitting area. The -2300 and -2400 series devices utilize LED chips which are made from GaAsP on a transparent GaP substrate. The -2500 series devices utilize chips made from GaP on a transparent GaP substrate.

## Selection Guide

| Light Bar Part Number HLMP- | | | Size of Light Emitting Area | Package Outline | | Corresponding Panel and Legend Mount Part No. HLMP- |
|---|---|---|---|---|---|---|
| High Efficiency Red | Yellow | Green | | | | |
| 2300 | 2400 | 2500 | 8.89 mm x 3.81 mm (.350 in. x .150 in.) | A | ▭ | 2599 |
| 2350 | 2450 | 2550 | 19.05 mm x 3.81 mm (.750 in. x .150 in.) | B | ▭ | 2598 |

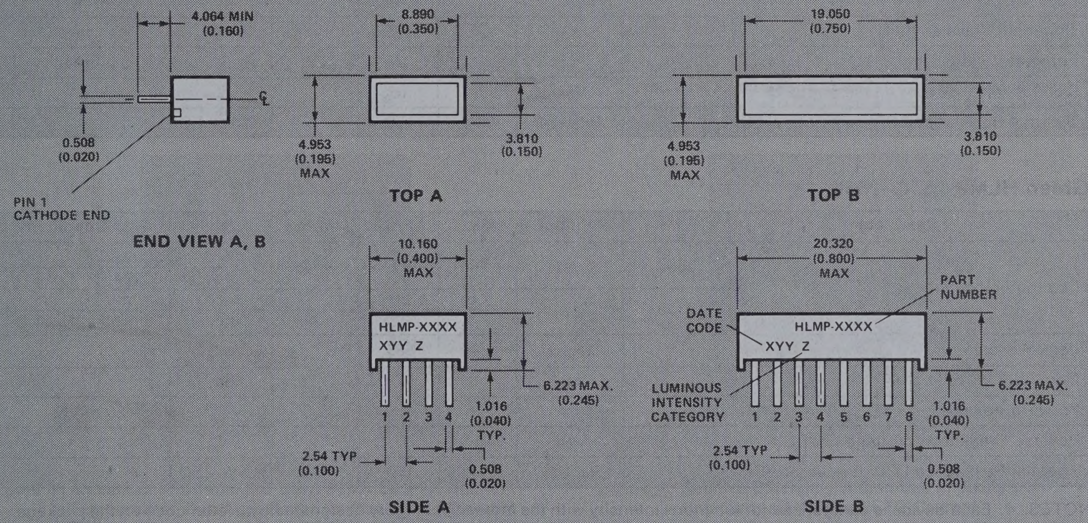
# Absolute Maximum Ratings

| Parameter | HLMP-2300/ 2500 Series | HLMP-2400 Series |
|---|---|---|
| Average Power Dissipation per LED Chip[1] | 135 mW | 85 mW |
| Peak Forward Current per LED Chip, $T_A = 50°C$ (Maximum Pulse Width = 2 ms)[1,2] | 90 mA | 60 mA |
| Time Average Forward Current per LED Chip, Pulsed Conditions[2] | 25 mA<br>$T_A = 25°C$ | 20 mA<br>$T_A = 50°C$ |
| DC Forward Current per LED Chip, $T_A = 50°C$[3] | 30 mA | 25 mA |
| Reverse Voltage per LED Chip | 6V | |
| Operating Temperature Range | -40° C to +85° C | |
| Storage Temperature Range | -40° C to +85° C | |
| Lead Soldering Temperature, 1.6 mm (1/16 inch) Below Seating Plane | 260° C for 3 Seconds | |

NOTES:

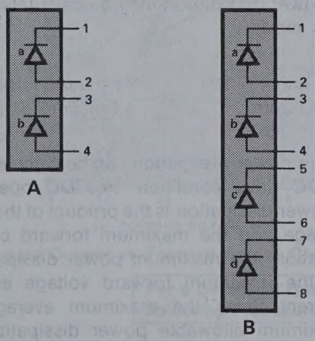
1. For HLMP-2300/-2500 series, derate above $T_A = 25°C$ at 1.8 mW/° C per LED Chip. For HLMP-2400 series, derate above $T_A = 50°C$ at 1.8 mW/° C per LED Chip. See Figure 2.
2. See Figure 1 to establish pulsed operating conditions.
3. For HLMP-2300/-2500 series, derate above $T_A = 50°C$ at 0.50 mA/° C per LED Chip. For HLMP-2400 series, derate above $T_A = 60°C$ at 0.50 mA/° C per LED Chip. See Figure 3.

# Package Dimensions


4.064 MIN (0.160)
℄
0.508 (0.020)
PIN 1 CATHODE END
END VIEW A, B
8.890 (0.350)
4.953 (0.195) MAX
3.810 (0.150)
TOP A
19.050 (0.750)
4.953 (0.195) MAX
3.810 (0.150)
TOP B
10.160 (0.400) MAX
HLMP-XXXX
XYY Z
6.223 MAX. (0.245)
1 2 3 4
1.016 (0.040) TYP.
2.54 TYP (0.100)
0.508 (0.020)
SIDE A
20.320 (0.800) MAX
PART NUMBER
DATE CODE
HLMP-XXXX
XYY Z
LUMINOUS INTENSITY CATEGORY
1 2 3 4 5 6 7 8
6.223 MAX. (0.245)
1.016 (0.040) TYP.
2.54 TYP (0.100)
0.508 (0.020)
SIDE B

NOTES: Dimensions in millimetres (inches).
Tolerances ±.25 mm (±0.010 in.) unless otherwise indicated.

# Internal Circuit Diagram


1
a
2
3
b
4
A
1
a
2
3
b
4
5
c
6
7
d
8
B

| PIN FUNCTION | | |
|---|---|---|
| PIN | A<br>-2300/-2400<br>-2500 | B<br>-2350/-2450<br>-2550 |
| 1 | Cathode — a | Cathode — a |
| 2 | Anode — a | Anode — a |
| 3 | Cathode — b | Cathode — b |
| 4 | Anode — b | Anode — b |
| 5 | | Cathode — c |
| 6 | | Anode — c |
| 7 | | Cathode — d |
| 8 | | Anode — d |

# Electrical/Optical Characteristics at $T_A$ = 25°C

### High Efficiency Red HLMP-2300/-2350

| Parameter | HLMP- | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] | 2300 | $I_V$ | 4.5 | 10 | | mcd | 20 mA DC |
| | | | | 15 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2350 | $I_V$ | 9 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| Peak Wavelength | | $\lambda_{Peak}$ | | 635 | | nm | |
| Dominant Wavelength[5] | | $\lambda_d$ | | 626 | | nm | |
| Forward Voltage per LED | | $V_F$ | | 1.9 | 2.6 | V | $I_F = 20$ mA |
| Reverse Breakdown Voltage per LED | | $V_{BR}$ | 6 | 15 | | V | $I_R = 100\ \mu A$ |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J-PIN}$ | | 150 | | °C/W/LED | |

### Yellow HLMP-2400/-2450

| Parameter | HLMP- | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] | 2400 | $I_V$ | 4 | 6 | | mcd | 20 mA DC |
| | | | | 10 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2450 | $I_V$ | 8 | 12 | | mcd | 20 mA DC |
| | | | | 20 | | mcd | 60 mA Pk: 1 of 3 DF |
| Peak Wavelength | | $\lambda_{PEAK}$ | | 583 | | nm | |
| Dominant Wavelength[5] | | $\lambda_d$ | | 585 | | nm | |
| Forward Voltage per LED | | $V_F$ | | 2 | 2.6 | V | $I_F = 20$ mA |
| Reverse Breakdown Voltage per LED | | $V_{BR}$ | 6 | 15 | | V | $I_R = 100\ \mu A$ |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J-PIN}$ | | 150 | | °C/W/LED | |

### Green HLMP-2500/-2550

| Parameter | HLMP- | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] | 2500 | $I_V$ | 3.7 | 10 | | mcd | 20 mA DC |
| | | | | 15 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2550 | $I_V$ | 7.5 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| Peak Wavelength | | $\lambda_{PEAK}$ | | 565 | | nm | |
| Dominant Wavelength[5] | | $\lambda_d$ | | 572 | | nm | |
| Forward Voltage per LED | | $V_F$ | | 2.1 | 2.6 | V | $I_F = 20$ mA |
| Reverse Breakdown Voltage per LED | | $V_{BR}$ | 6 | 15 | | V | $I_R = 100\ \mu A$ |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J-PIN}$ | | 150 | | °C/W/LED | |

NOTES: 4. Each device is categorized for luminous intensity with the intensity category designated by a letter code on the package.
5. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and is that single wavelength which defines the color of the device.

# Electrical

The HLMP-2300/-2400/-2500 series of light bar devices are composed of two or four light emitting diodes, with the light from each LED optically scattered to form an evenly illuminated light emitting surface. The LED's have a P-N junction diffused into the epitaxial layer on a GaP transparent substrate.

The anode and cathode of each LED is brought out by separate pins. This universal pinout arrangement allows for the wiring of the LED's within a device in any of three possible configurations: parallel, series, or series/parallel.

The typical forward voltage values, scaled from Figure 5, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design and maximum power dissipation may be calculated using the following $V_F$ models:

$$V_F = 1.8V + I_{PEAK}\,(40\Omega) \quad \text{For } I_{PEAK} \geq 20mA$$

$$V_F = 1.6V + I_{DC}\,(50\Omega) \quad \text{For } 5mA \leq I_{DC} \leq 20mA$$

The maximum power dissipation can be calculated for any pulsed or DC drive condition. For DC operation, the maximum power dissipation is the product of the maximum forward voltage and the maximum forward current. For pulsed operation, the maximum power dissipation is the product of the maximum forward voltage at the peak forward current times the maximum average forward current. Maximum allowable power dissipation for any given ambient temperature and thermal resistance ($R\theta_{J-A}$) can be determined by using Figure 2. The solid line in Figure 2 ($R\theta_{J-A}$ of 538° C/W) represents a typical thermal resistance of a device socketed in a printed circuit board. The dashed lines represent achievable thermal resistances that can be obtained through improved thermal design. Once the maximum allowable power dissipation is determined, the maximum pulsed or DC forward current can be calculated.

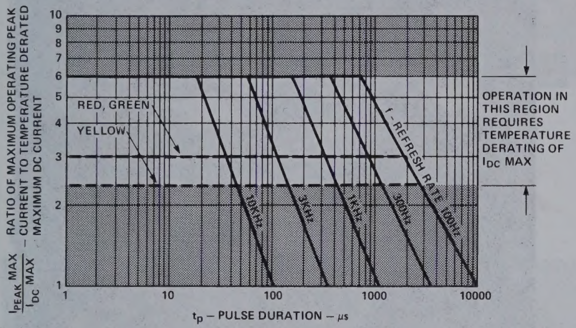


**Figure 1. Maximum Allowed Peak Current vs. Pulse Duration**

# Optical

The radiation pattern for these light bar devices is approximately Lambertian. The luminous sterance may be calculated using one of the two following formulas:

$$L_V(\mathrm{cd/m^2}) = \frac{I_V(\mathrm{cd})}{A(\mathrm{m^2})} \qquad L_V(\mathrm{footlamberts}) = \frac{\pi I_V(\mathrm{cd})}{A(\mathrm{ft^2})}$$

| SIZE OF EMITTING AREA | SURFACE AREA | |
|---|---|---|
| | SQ. METRES | SQ. FEET |
| 8.89mm x 3.81mm | $33.87 \times 10^{-6}$ | $364.58 \times 10^{-6}$ |
| 19.05mm x 3.81mm | $72.58 \times 10^{-6}$ | $781.25 \times 10^{-6}$ |

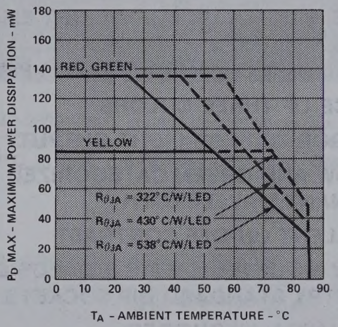


**Figure 2. Maximum Allowable Power Dissipation per LED vs. Ambient Temperature Deratings based on Maximum Allowable Thermal Resistance Values, LED Junction to Ambient on a per LED Basis, Tj MAX = 100° C.**

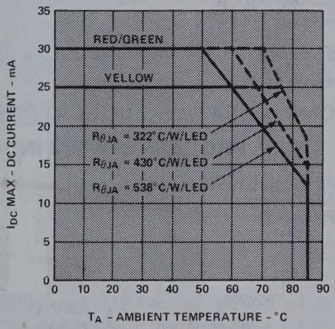


**Figure 3. Maximum Allowable DC Current per LED vs. Ambient Temperature, Deratings Based on Maximum Allowable Thermal Resistance Values, LED Junction-to-Ambient on a per LED Basis, Tj MAX = 100° C.**

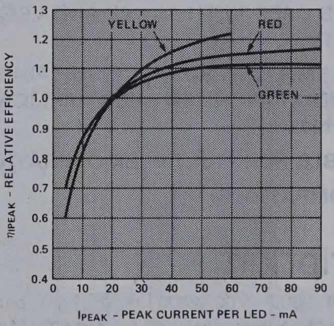


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current.**

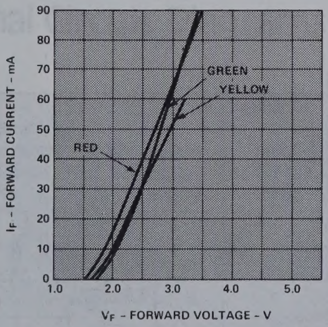


**Figure 5. Forward Current vs. Forward Voltage Characteristics.**

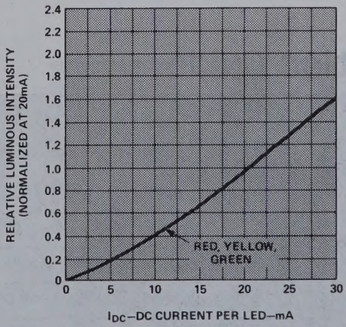


**Figure 6. Relative Luminous Intensity vs. DC Forward Current.**

**For a Detailed Explanation on the Use of Data Sheet Information and Soldering Procedures, See Application Note 1005.**

**HEWLETT PACKARD**

# LED LIGHT BARS

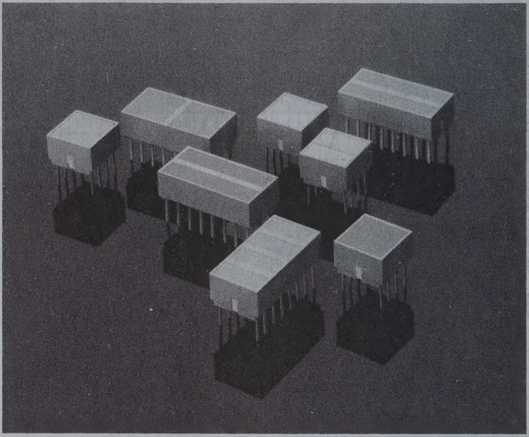
## DIP — Single or Segmented Light Emitting Areas

### HIGH EFFICIENCY RED HLMP-2600 SERIES
### YELLOW HLMP-2700 SERIES
### HIGH PERFORMANCE GREEN HLMP-2800 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **LARGE, BRIGHT, UNIFORM LIGHT EMITTING AREAS**
  **Approximately Lambertian Radiation Pattern**
- **CHOICE OF THREE COLORS**
- **CATEGORIZED FOR LIGHT OUTPUT**
- **YELLOW AND GREEN CATEGORIZED FOR DOMINANT WAVELENGTH**
- **EXCELLENT ON-OFF CONTRAST**
- **EASILY MOUNTED ON P.C. BOARDS OR INDUSTRY STANDARD DIP SOCKETS**
- **MECHANICALLY RUGGED**
- **X-Y STACKABLE**
- **FLUSH MOUNTABLE**
- **CAN BE USED WITH PANEL AND LEGEND MOUNTS**
- **LIGHT EMITTING SURFACE SUITABLE FOR LEGEND ATTACHMENT PER APPLICATION NOTE 1012**
- **SUITABLE FOR MULTIPLEX OPERATION**
- **I.C. COMPATIBLE**



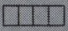
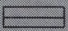
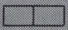
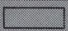
## Applications

- **BUSINESS MACHINE MESSAGE ANNUNCIATORS**
- **TELECOMMUNICATIONS INDICATORS**
- **FRONT PANEL PROCESS STATUS INDICATORS**
- **PC BOARD IDENTIFIERS**
- **BAR GRAPHS**

## Description

The HLMP-2600/-2700/-2800 series light bars are rectangular light sources designed for a variety of applications where a large, bright source of light is required. These light bars are configured in dual-in-line packages that contain either single or segmented light emitting areas. The -2600 and -2700 series devices utilize LED chips which are made from GaAsP on a transparent GaP substrate. The -2800 series devices utilize chips made from GaP on a transparent GaP substrate.

## Selection Guide

| Light Bar Part Number HLMP- | | | Size of Light Emitting Areas | Number of Light Emitting Areas | Package Outline | | Corresponding Panel and Legend Mount Part No. HLMP- |
|---|---|---|---|---|---|---|---|
| High Efficiency Red | Yellow | Green | | | | | |
| 2600 | 2700 | 2800 | 8.89 mm x 3.81 mm (.350 in. x .150 in.) | 2 | B | | 2898 |
| 2620 | 2720 | 2820 | 8.89 mm x 3.81 mm (.350 in. x .150 in.) | 4 | D |  | 2899 |
| 2635 | 2735 | 2835 | 8.89 mm x 19.05 mm (.150 in. x .750 in.) | 2 | E |  | 2899 |
| 2655 | 2755 | 2855 | 8.89 mm x 8.89 mm (.350 in. x .350 in.) | 1 | A | | 2898 |
| 2670 | 2770 | 2870 | 8.89 mm x 8.89 mm (.350 in. x .350 in.) | 2 | C |  | 2899 |
| 2685 | 2785 | 2885 | 8.89 mm x 19.05 mm (.350 in. x .750 in.) | 1 | F |  | 2899 |

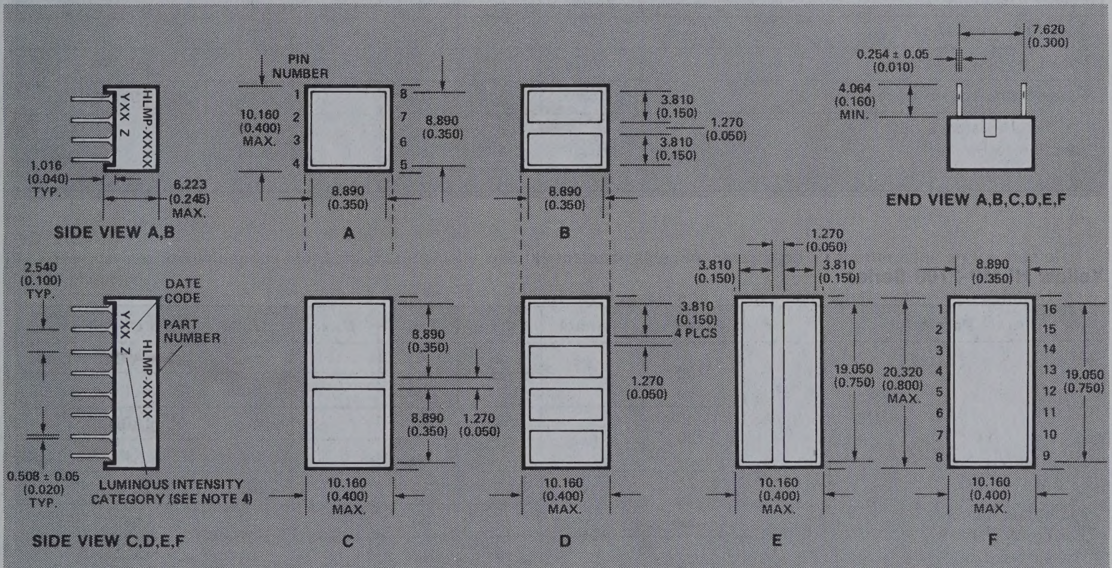
## Absolute Maximum Ratings

| Parameter | HLMP-2600/ 2800 Series | HLMP-2700 Series |
|---|---|---|
| Average Power Dissipation per LED Chip[1] | 135 mW | 85 mW |
| Peak Forward Current per LED Chip, $T_A$ = 50° C (Maximum Pulse Width = 2 ms)[1,2] | 90 mA | 60 mA |
| Time Average Forward Current per LED Chip, Pulsed Conditions[2] | 25 mA,<br>$T_A$ = 25° C | 20 mA,<br>$T_A$ = 50° C |
| DC Forward Current per LED Chip, $T_A$ = 50° C[3] | 30 mA | 25 mA |
| Reverse Voltage per LED Chip | 6V | |
| Operating Temperature Range | -40° C to +85° C | |
| Storage Temperature Range | -40° C to +85° C | |
| Lead Soldering Temperature, 1.6 mm (1/16 inch) Below Seating Plane | 260° C for 3 Seconds | |

NOTES:

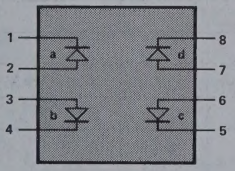
1. For HLMP-2600/-2800 series, derate above $T_A$ = 25°C at 1.8 mW/° C per LED chip. For HLMP-2700 series, derate above $T_A$ = 50°C at 1.8 mW/°C per LED chip. See Figure 2.
2. See Figure 1 to establish pulsed operating conditions.
3. For HLMP-2600/-2800 series, derate above $T_A$ = 50°C at 0.50 mA/° C per LED chip. For HLMP-2700 series, derate above $T_A$ = 60°C at 0.50 mA/°C per LED chip. See Figure 3.

## Package Dimensions

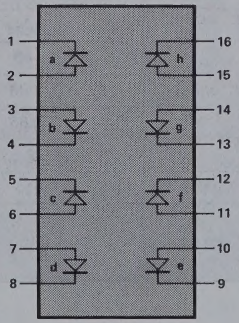

HLMP-XXXX
YXX Z
1.016 (0.040) TYP.
6.223 (0.245) MAX.
SIDE VIEW A,B
PIN NUMBER
10.160 (0.400) MAX.
1 2 3 4 5 6 7 8
8.890 (0.350)
8.890 (0.350)
A
3.810 (0.150)
1.270 (0.050)
3.810 (0.150)
8.890 (0.350)
B
7.620 (0.300)
0.254 ± 0.05 (0.010)
4.064 (0.160) MIN.
END VIEW A,B,C,D,E,F
2.540 (0.100) TYP.
DATE CODE
PART NUMBER
0.508 ± 0.05 (0.020) TYP.
LUMINOUS INTENSITY CATEGORY (SEE NOTE 4)
SIDE VIEW C,D,E,F
8.890 (0.350)
8.890 (0.350)
1.270 (0.050)
10.160 (0.400) MAX.
C
3.810 (0.150) 4 PLCS
1.270 (0.050)
10.160 (0.400) MAX.
D
3.810 (0.150)
1.270 (0.050)
3.810 (0.150)
19.050 (0.750)
20.320 (0.800) MAX.
10.160 (0.400) MAX.
E
8.890 (0.350)
1 2 3 4 5 6 7 8
16 15 14 13 12 11 10 9
19.050 (0.750)
10.160 (0.400) MAX.
F

NOTE: DIMENSIONS IN MILLIMETRES (INCHES). TOLERANCES ±0.25 mm (±0.010 in) UNLESS OTHERWISE INDICATED.

## Internal Circuit Diagrams


1
2
3
4
a
b
d
c
8
7
6
5

A,B


1
2
3
4
5
6
7
8
a
b
c
d
h
g
f
e
16
15
14
13
12
11
10
9

C,D,E,F

| PIN | PIN FUNCTION | |
|---|---|---|
| | A, B | C, D, E, F |
| 1 | CATHODE a | CATHODE a |
| 2 | ANODE a | ANODE a |
| 3 | ANODE b | ANODE b |
| 4 | CATHODE b | CATHODE b |
| 5 | CATHODE c | CATHODE c |
| 6 | ANODE c | ANODE c |
| 7 | ANODE d | ANODE d |
| 8 | CATHODE d | CATHODE d |
| 9 | | CATHODE e |
| 10 | | ANODE e |
| 11 | | ANODE f |
| 12 | | CATHODE f |
| 13 | | CATHODE g |
| 14 | | ANODE g |
| 15 | | ANODE h |
| 16 | | CATHODE h |

# Electrical/Optical Characteristics at $T_A$=25°C

## High Efficiency Red HLMP-2600 Series

| Parameter | HLMP- | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] Per Light Emitting Area | 2600 | $I_V$ | 4.5 | 10 | | mcd | 20 mA DC |
| | | | | 15 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2620 | $I_V$ | 4.5 | 10 | | mcd | 20 mA DC |
| | | | | 15 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2635 | $I_V$ | 9 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2655 | $I_V$ | 9 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2670 | $I_V$ | 9 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2685 | $I_V$ | 18 | 40 | | mcd | 20 mA DC |
| | | | | 60 | | mcd | 60 mA Pk: 1 of 3 DF |
| Peak Wavelength | | $\lambda_{peak}$ | | 635 | | nm | |
| Dominant Wavelength[5] | | $\lambda_d$ | | 626 | | nm | |
| Forward Voltage Per LED | | $V_F$ | | 2.1 | 2.6 | V | $I_F$ = 20 mA |
| Reverse Breakdown Voltage Per LED | | $V_{BR}$ | 6 | 15 | | V | $I_R$ = 100$\mu$A |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J-PIN}$ | | 150 | | °C/W/ LED Chip | |

## Yellow HLMP-2700 Series

| Parameter | HLMP- | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] Per Light Emitting Area | 2700 | $I_V$ | 4 | 6 | | mcd | 20 mA DC |
| | | | | 10 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2720 | $I_V$ | 4 | 6 | | mcd | 20 mA DC |
| | | | | 10 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2735 | $I_V$ | 8 | 12 | | mcd | 20 mA DC |
| | | | | 20 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2755 | $I_V$ | 8 | 12 | | mcd | 20 mA DC |
| | | | | 20 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2770 | $I_V$ | 8 | 12 | | mcd | 20 mA DC |
| | | | | 20 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2785 | $I_V$ | 16 | 24 | | mcd | 20 mA DC |
| | | | | 40 | | mcd | 60 mA Pk: 1 of 3 DF |
| Peak Wavelength | | $\lambda_{peak}$ | | 583 | | nm | |
| Dominant Wavelength[5] | | $\lambda_d$ | | 585 | | nm | |
| Forward Voltage Per LED | | $V_F$ | | 2.2 | 2.6 | V | $I_F$ = 20 mA |
| Reverse Breakdown Voltage Per LED | | $V_{BR}$ | 6 | 15 | | V | $I_R$ = 100 $\mu$A |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J-PIN}$ | | 150 | | °C/W/ LED Chip | |

# Electrical/Optical Characteristics at $T_A = 25°C$

**Green HLMP-2800 Series**

| Parameter | HLMP- | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] Per Light Emitting Area | 2800 | $I_V$ | 3.7 | 10 | | mcd | 20 mA DC |
| | | | | 15 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2820 | $I_V$ | 3.7 | 10 | | mcd | 20 mA DC |
| | | | | 15 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2835 | $I_V$ | 7.5 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2855 | $I_V$ | 7.5 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2870 | $I_V$ | 7.5 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 DF |
| | 2885 | $I_V$ | 15 | 40 | | mcd | 20 mA DC |
| | | | | 60 | | mcd | 60 mA Pk: 1 of 3 DF |
| Peak Wavelength | | $\delta_{peak}$ | | 565 | | nm | |
| Dominant Wavelength[5] | | $\delta_d$ | | 572 | | nm | |
| Forward Voltage Per LED | | $V_F$ | | 2.2 | 2.6 | V | $I_F = 20$ mA |
| Reverse Breakdown Voltage Per LED | | $V_{BR}$ | 6 | 15 | | V | $I_R = 100\ \mu A$ |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J\text{-}PIN}$ | | 150 | | °C/W/ LED Chip | |

NOTES:
4. These devices are categorized for luminous intensity with the intensity category designated by a letter code on the side of the package.
5. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and is that single wavelength which defines the color of the device.

# Electrical

The HLMP-2600/-2700/-2800 series of light bar devices are composed of four or eight light emitting diodes, with the light from each LED optically scattered to form an evenly illuminated light emitting surface. The LED's have a P-N junction diffused into the epitaxial layer on a GaP transparent substrate.

The anode and cathode of each LED is brought out by separate pins. This universal pinout arrangement allows for the wiring of the LED's within a device in any of three possible configurations: parallel, series, or series/parallel.

The typical forward voltage values, scaled from Figure 5, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design and maximum power dissipation may be calculated using the following $V_F$ models:

$$V_F = 1.8V + I_{PEAK}\,(40\Omega)$$
For $I_{PEAK} \geq 20mA$

$$V_F = 1.6V + I_{DC}\,(50\Omega)$$
For $5mA \leq I_{DC} \leq 20mA$

The maximum power dissipation can be calculated for any pulsed or DC drive condition. For DC operation, the maximum power dissipation is the product of the maximum forward voltage and the maximum forward current. For pulsed operation, the maximum power dissipation is the product of the maximum forward voltage at the peak forward current times the maximum average forward current. Maximum allowable power dissipation for any given ambient temperature and thermal resistance ($R\theta_{J-A}$) can be determined by using Figure 2. The solid line in Figure 2 ($R\theta_{J-A}$ of 538°C/W) represents a typical thermal resistance of a device socketed in a printed circuit board. The dashed lines represent achievable thermal resistances that can be obtained through improved thermal design. Once the maximum allowable power dissipation is determined, the maximum pulsed or DC forward current can be calculated.

# Optical

The radiation pattern for these light bar devices is approximately Lambertian. The luminous sterance may be calculated using one of the two following formulas:

$$L_v\ (\text{cd/m}^2) = \frac{I_v\ (\text{cd})}{A\ (\text{m}^2)}$$

$$L_v\ (\text{footlamberts}) = \frac{\pi I_v\ (\text{cd})}{A\ (\text{ft}^2)}$$

| Size of Light Emitting Area | Surface Area | |
|---|---|---|
| | Sq. Metres | Sq. Feet |
| 8.89 mm x 8.89 mm | $67.74 \times 10^{-6}$ | $729.16 \times 10^{-6}$ |
| 8.89 mm x 3.81 mm | $33.87 \times 10^{-6}$ | $364.58 \times 10^{-6}$ |
| 8.89 mm x 19.05 mm | $135.48 \times 10^{-6}$ | $1458.32 \times 10^{-6}$ |
| 3.81 mm x 19.05 mm | $72.58 \times 10^{-6}$ | $781.25 \times 10^{-6}$ |

Refresh rates of 1 kHz or faster provide the most efficient operation resulting in the maximum possible time average luminous intensity.

The time average luminous intensity may be calculated using the relative efficiency characteristic of Figure 3, $\eta_{\text{IPEAK}}$, and adjusted for operating ambient temperature. The time average luminous intensity at $T_A = 25°C$ is calculated as follows:

$$I_{v\ \text{TIME AVG}} = \left[\frac{I_{\text{AVG}}}{20\text{mA}}\right] (\eta_{I_{\text{PEAK}}})\ (I_v\ \text{Data Sheet})$$

Example: For HLMP-2735 series

$$\eta_{I_{\text{PEAK}}} = 1.18 \text{ at } I_{\text{PEAK}} = 48 \text{ mA}$$

$$I_{v\ \text{TIME AVG}} = \left[\frac{12\text{mA}}{20\text{mA}}\right]\ (1.18)\ (10\ \text{mcd}) = 7\ \text{mcd}$$

The time average luminous intensity may be adjusted for operating ambient temperature by the following exponential equation:

$$I_v\ (T_A) = I_v\ (25°C)\ e^{[K\ (T_A\ -\ 25°C)]}$$

| Device | K |
|---|---|
| -2600 Series | -0.0131/°C |
| -2700 Series | -0.0112/°C |
| -2800 Series | -0.0104/°C |

Example: $I_v\ (80°C) = (7\ \text{mcd})\ e^{[-0.0112\ (80-25)]} = 3.8\text{mcd}$

These light bar devices may be operated in ambient temperatures above +60°C without derating when installed in a PC board configuration that provides a thermal resistance to ambient value less than 250°C/W/LED. See Figure 6 to determine the maximum allowed thermal resistance for the PC board, $R_{\theta\text{PC-A}}$, which will permit nonderated operation in a given ambient temperature.

To optimize device optical performance, specially developed plastics are used which restrict the solvents that may be used for cleaning. It is recommended that only mixtures of Freon (F113) and alcohol be used for vapor cleaning processes, with an immersion time in the vapors of less than two (2) minutes maximum. Some suggested vapor cleaning solvents are Freon TE, Genesolv DI-15 or DE-15, Arklone A or K. A 60°C (140°F) water cleaning process may also be used, which includes a neutralizer rinse (3% ammonia solution or equivalent), a surfactant rinse (1% detergent solution or equivalent), a hot water rinse and a thorough air dry. Room temperature cleaning may be accomplished with Freon T-E35 or T-P35, Ethanol, Isopropanol or water with a mild detergent.

# Mechanical

These devices are constructed utilizing a lead frame in a DIP package. The LED dice are attached directly to the lead frame. Therefore, the cathode leads are the direct thermal and mechanical stress paths to the LED dice. The absolute maximum allowed junction temperature, $T_{J\ \text{MAX}}$, is 100°C. The maximum power ratings have been established so that the worst case $V_F$ device does not exceed this limit. For most reliable operation, it is recommended that the device pin-to-ambient thermal resistance through the PC board be less than 250°C/W/LED. This will then establish a maximum thermal resistance LED junction-to-ambient of 400°C/W/LED.

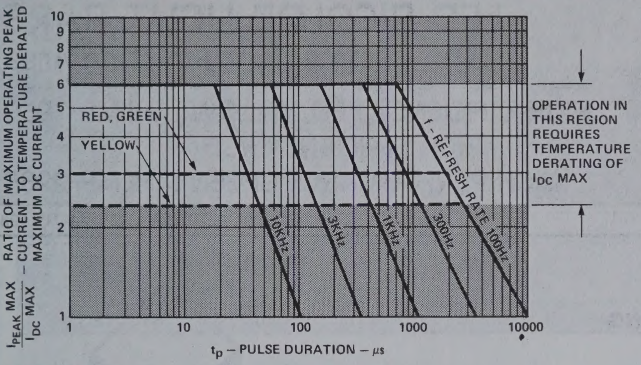


**Figure 1. Maximum Allowed Peak Current vs. Pulse Duration.**

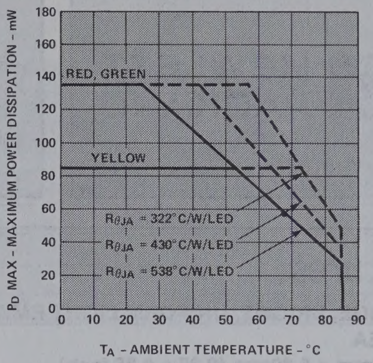


**Figure 2. Maximum Allowable Power Dissipation per LED vs. Ambient Temperature Deratings Based on Maximum Allowable Thermal Resistance Values, LED Junction to Ambient on a per LED Basis, Tj MAX = 100° C.**

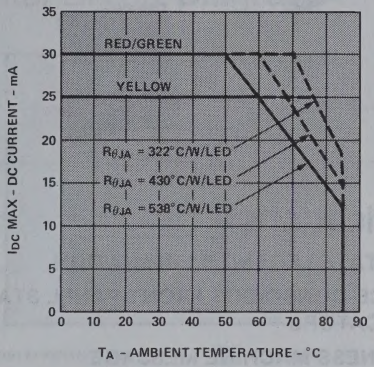


**Figure 3. Maximum Allowable DC Current per LED vs. Ambient Temperature, Deratings Based on Maximum Allowable Thermal Resistance Values, LED Junction-to-Ambient on a per LED Basis, Tj MAX = 100° C.**

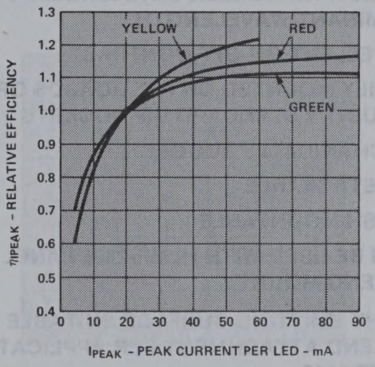


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current.**

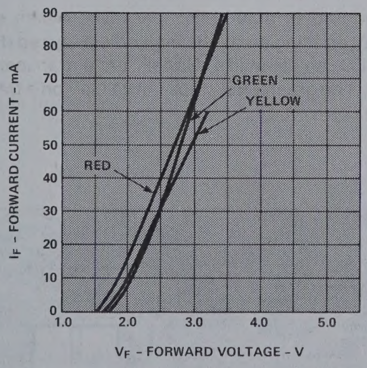


**Figure 5. Forward Current vs. Forward Voltage Characteristics.**

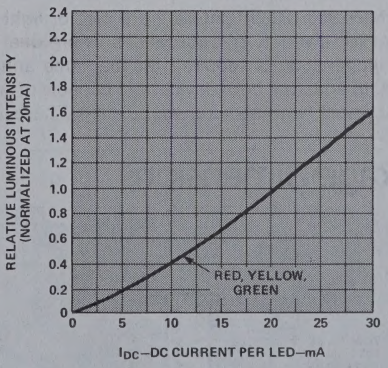


**Figure 6. Relative Luminous Intensity vs. DC Forward Current.**

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

**HEWLETT PACKARD**

# LED BICOLOR LIGHT BARS

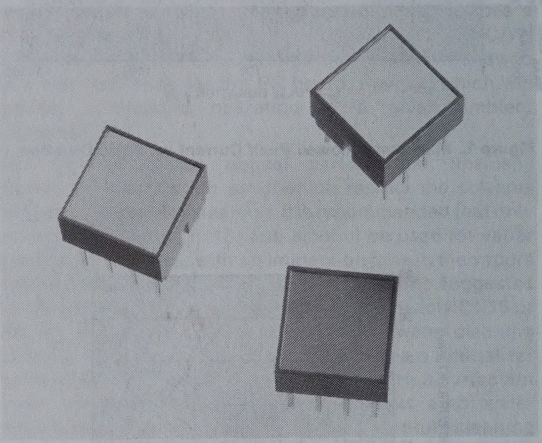
## DIP — Single Light Emitting Area

### HIGH EFFICIENCY RED/YELLOW HLMP-2950
### HIGH EFFICIENCY RED/ HIGH PERFORMANCE GREEN HLMP-2965

TECHNICAL DATA FEBRUARY 1982

## Features

- LARGE, BRIGHT, UNIFORM LIGHT EMITTING AREA
  8.89mm x 8.89mm (0.35 x 0.35 inch)
  Approximately Lambertian Radiation Pattern
- CHOICE OF TWO BICOLOR COMBINATIONS
- CATEGORIZED FOR LIGHT OUTPUT
- YELLOW AND GREEN CATEGORIZED FOR DOMINANT WAVELENGTH
- EXCELLENT ON-OFF CONTRAST
- EASILY MOUNTED ON P.C. BOARDS OR INDUSTRY STANDARD DIP SOCKETS
- MECHANICALLY RUGGED
- X-Y STACKABLE
- FLUSH MOUNTABLE
- CAN BE USED WITH HLMP-2898 PANEL AND LEGEND MOUNT
- LIGHT EMITTING SURFACE SUITABLE FOR LEGEND ATTACHMENT PER APPLICATION NOTE 1012
- I.C. COMPATIBLE



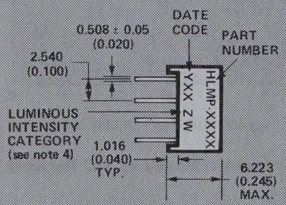
## Applications

- TRISTATE LEGEND ILLUMINATION
- SPACE-CONSCIOUS FRONT PANEL STATUS INDICATORS
- BUSINESS MACHINE MESSAGE ANNUNCIATORS
- TELECOMMUNICATIONS INDICATORS
- TWO FUNCTION LIGHTED SWITCHES

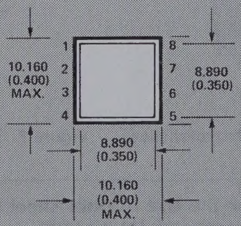
## Description

The HLMP-2950/-2965 light bars are bicolor light sources designed for a variety of applications where dual state or tristate illumination is required for the same annunciator function. In addition, both devices are capable of emitting a range of colors by pulse width modulation. These light bars are configured in dual-in-line packages which contain a single light emitting area. The high efficiency red (HER) and yellow LED chips utilize GaAsP on a transparent GaP substrate. The green LED chips utilize GaP on a transparent substrate.

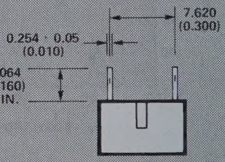
## Package Dimensions


DATE CODE
PART NUMBER
0.508 ± 0.05 (0.020)
2.540 (0.100)
LUMINOUS INTENSITY CATEGORY (see note 4)
1.016 (0.040) TYP.
6.223 (0.245) MAX.
HLMP-XXXX
YXX ZW

SIDE VIEW


10.160 (0.400) MAX.
1
2
3
4
8
7
6
5
8.890 (0.350)
8.890 (0.350)
10.160 (0.400) MAX.

TOP VIEW


7.620 (0.300)
0.254 ± 0.05 (0.010)
4.064 (0.160) MIN.

END VIEW

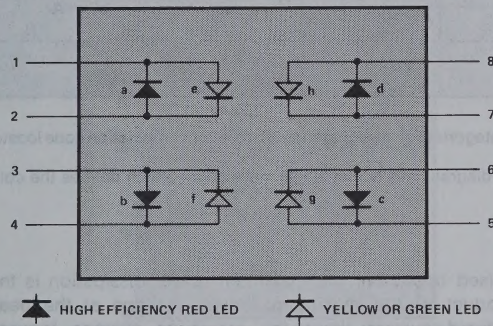
NOTES: DIMENSIONS IN MILLIMETRES (INCHES).
TOLERANCES ±0.25 mm (±0.010 in) UNLESS OTHERWISE INDICATED.

# Absolute Maximum Ratings

| Parameter | HLMP-2965 | HLMP-2950 |
|---|---|---|
| Average Power Dissipation per LED Chip[1] | 135 mW | 85 mW |
| Peak Forward Current per LED Chip, $T_A = 50°C$ (Maximum Pulse Width = 2 ms)[1,2] | 90 mA | 60 mA |
| Time Average Forward Current per LED Chip, Pulsed Conditions[2] | 25 mA, $T_A = 25°C$ | 20 mA, $T_A = 50°C$ |
| DC Forward Current per LED Chip, $T_A = 50°C$[3] | 30 mA | 25 mA |
| Operating Temperature Range | -40°C to +85°C | |
| Storage Temperature Range | -40°C to +85°C | |
| Lead Soldering Temperature, 1.6 mm (1/16 inch) Below Seating Plane | 260°C for 3 seconds | |

NOTES:
1. For HLMP-2965, derate above $T_A = 25°C$ at 1.8 mW/°C per LED chip. For HLMP-2950 derate above $T_A = 50°C$ at 1.8 mW/°C per LED chip. See Figure 2.
2. See Figure 1 to establish pulsed operating conditions.
3. For HLMP-2965, derate above $T_A = 50°C$ at 0.50 mA/°C per LED chip. For HLMP-2950, derate above $T_A = 60°C$ at 0.50 mA/°C per LED chip. See Figure 3.

# Internal Circuit Diagram



| PIN | PIN FUNCTION | |
|---|---|---|
| | HER | YELLOW or GREEN |
| 1 | CATHODE a | ANODE e |
| 2 | ANODE a | CATHODE e |
| 3 | ANODE b | CATHODE f |
| 4 | CATHODE b | ANODE f |
| 5 | CATHODE c | ANODE g |
| 6 | ANODE c | CATHODE g |
| 7 | ANODE d | CATHODE h |
| 8 | CATHODE d | ANODE h |

# Electrical/Optical Characteristics at $T_A = 25°C$

**HIGH EFFICIENCY RED/YELLOW HLMP-2950**

| Parameter | | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] | HER | $I_V$ | 9 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 Duty Factor |
| | Yellow | $I_V$ | 8 | 12 | | mcd | 20 mA DC |
| | | | | 20 | | mcd | 60 mA Pk: 1 of 3 Duty Factor |
| Peak Wavelength | HER | $\lambda_{PEAK}$ | | 635 | | nm | |
| | Yellow | | | 583 | | | |
| Dominant Wavelength[5] | HER | $\lambda_d$ | | 626 | | nm | |
| | Yellow | | | 585 | | | |
| Forward Voltage | HER | $V_F$ | | 2.1 | 2.6 | V | $I_F = 20$ mA |
| | Yellow | | | 2.2 | 2.6 | | |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J-PIN}$ | | 150 | | °C/W/LED | |

# Electrical/Optical Characteristics at $T_A = 25°C$

**HIGH EFFICIENCY RED/GREEN HLMP-2965**

| Parameter | | Symbol | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Luminous Intensity[4] | HER | $I_V$ | 9 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 Duty Factor |
| | Green | $I_V$ | 7.5 | 20 | | mcd | 20 mA DC |
| | | | | 30 | | mcd | 60 mA Pk: 1 of 3 Duty Factor |
| Peak Wavelength | HER | $\lambda_{PEAK}$ | | 635 | | nm | |
| | Green | | | 565 | | | |
| Dominant Wavelength[5] | HER | $\lambda_d$ | | 626 | | nm | |
| | Green | | | 572 | | | |
| Forward Voltage | HER | $V_F$ | | 2.1 | 2.6 | V | $I_F = 20$ mA |
| | Green | | | 2.2 | 2.6 | | |
| Thermal Resistance LED Junction-to-Pin | | $R\theta_{J-PIN}$ | | 150 | | °C/W/LED | |

NOTES:

4. These devices are categorized for luminous intensity with the intensity categorization designated by a two letter combination code located on the side of the package (Z = HER, W = Yellow or Green).
5. The dominant wavelength, $\lambda_d$, is derived from the C.I.E. chromaticity diagram and is that single wavelength which defines the color of the device.

## Electrical

The HLMP-2950/-2965 bicolor light bar devices are composed of eight light emitting diodes: four High Efficiency Red and four that are either Yellow or Green. The light from each LED is optically scattered to form an evenly illuminated light emitting surface. The LED's are die attached and wire bonded in bicolor pairs, with the anode/cathode of each LED pair brought out by separate pins.

The typical forward voltage values, scaled from Figure 5, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design and maximum power dissipation may be approximated using the following $V_F$ models:

$$V_F = 1.8V + I_{PEAK}\,(40\Omega)$$
$$\text{For } I_{PEAK} \geq 20 \text{ mA}$$

$$V_F = 1.6V + I_{DC}\,(50\Omega)$$
$$\text{For } 5 \text{ mA} \leq I_{DC} \leq 20 \text{ mA}$$

The maximum power dissipation can be calculated for any pulsed or DC drive condition. For DC operation, the maximum power dissipation is the product of the maximum forward voltage and the maximum forward current. For pulsed operation, the maximum power dissipation is the product of the maximum forward voltage at the peak forward current times the maximum average forward current. Maximum allowable power dissipation for any given ambient temperature and thermal resistance ($R\theta_{J-A}$) can be determined by using Figure 2. The solid line in Figure 2 ($R\theta_{J-A}$ of 538° C/W) represents a typical thermal resistance of a device socketed in a printed circuit board. The dashed lines represent achievable thermal resistance that can be obtained through improved thermal design. Once the maximum allowable power dissipation is determined, the maximum pulsed or DC forward current can be calculated.

## Optical

The radiation pattern for these light bar devices is approximately Lambertian. The luminous sterance may be calculated using one of the two following formulas:

$$L_v\,(\text{cd/m}^2) = \frac{I_v\,(\text{cd})}{A\,(\text{m}^2)} \qquad L_v\,(\text{footlamberts}) = \frac{\pi I_v\,(\text{cd})}{A\,(\text{ft}^2)}$$

where the area (A) of the light emitting surface is 67.74 x $10^{-6}$ m$^2$ (729.16 x $10^{-6}$ ft.$^2$).

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, see Application Note 1005.**

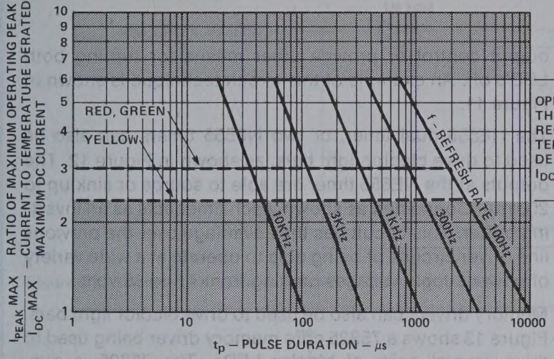


**Figure 1. Maximum Allowed Peak Current vs. Pulse Duration.**

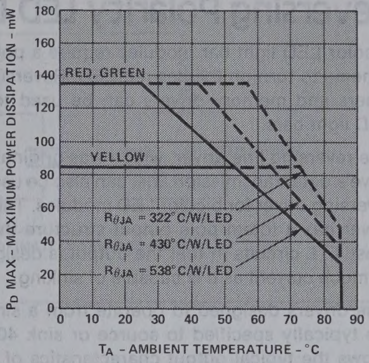


**Figure 2. Maximum Allowable Power Dissipation per LED vs. Ambient Temperature. Deratings based on Maximum Allowable Thermal Resistance Values, LED Junction to Ambient on a per LED Basis, Tj MAX = 100° C.**

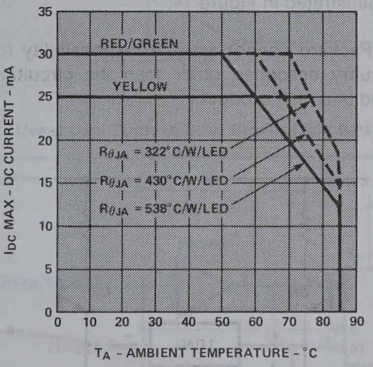


**Figure 3. Maximum Allowable DC Current per LED vs. Ambient Temperature, Deratings Based on Maximum Allowable Thermal Resistance Values, LED Junction-to-Ambient on a per LED Basis, Tj MAX = 100° C.**

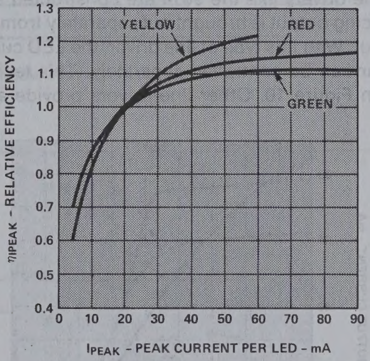


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak`LED Current.**

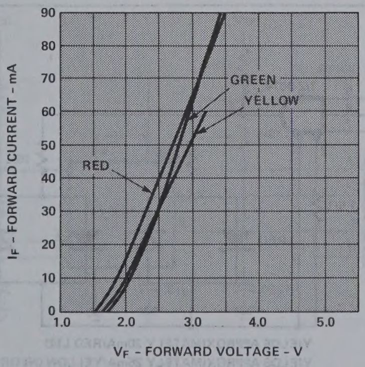


**Figure 5. Forward Current vs. Forward Voltage Characteristics.**

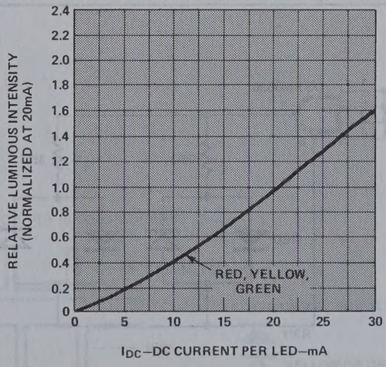


**Figure 6. Relative Luminous Intensity vs. DC Forward Current.**

# Reversing Polarity LED Drivers

Bicolor LED light bar modules require a polarity reversing scheme to turn on the desired LED. Reversing line drivers, timers and memory drivers can be used to drive bicolor LED light bars.

The reversing line driver, which was originally designed to drive a data transmission line, can also be used as a polarity reversing driver for bicolor LED modules. The reversing line driver has a totem pole output structure that differs from most TTL circuits in that the output is designed to source as much current as it is capable of sinking.

Line drivers designed to operate from a single 5V supply are typically specified to source or sink 40 mA. Figure 7 shows the typical output characteristics of three different line drivers connected so that one output sources current across a load and the current is sunk by another output. This circuit is shown in Figure 8. At 40 mA output current, the output voltage typically varies from 2.4V (74128) to 2.9V (DM 8830, 9614) for $V_{CC} = 5.0V$. A basic bicolor LED circuit is shown in Figure 9. Since a line driver can supply 40 mA, it is capable of driving two LED pairs.

Some line drivers like the 9614 are constructed such that the sourcing output is brought out separately from the sinking output. With this type of line driver, the LED currents for each pair can be controlled separately. This technique is shown in Figure 10. Other line drivers provide a tri-state output control or provide other means for turning both LED's off. An example of this circuit technique is shown in Figure 11.

The NE556 dual timer, or two NE555 timers can also be used to drive bicolor light bars, as shown in Figure 12. The outputs at the NE555 timer are able to source or sink up to 200 mA. Connected as shown, each timer acts as an inverting buffer. This circuit has the advantage over the previous line driver circuits of being able to operate at a wide variety of power supply voltages ranging from 4.5 to 16 volts.

Memory drivers can also be used to drive bicolor light bars. Figure 13 shows a 75325 core memory driver being used to drive several pairs of bicolor LEDs. The 75325 is guaranteed to supply up to 600 mA of current with an output voltage considerably higher than 5V line drivers. The 75325 requires an additional 7.5V power supply at about 40 mA to properly bias the sourcing drivers. The 75325 allows tri-state (red, green or yellow, off) operation.

By employing pulse width modulation techniques to any of these circuits a range of colors can be obtained. This technique is illustrated in Figure 14.

Hewlett-Packard cannot assume responsibility for use of any circuitry described other than the circuitry entirely embodied in an HP product.

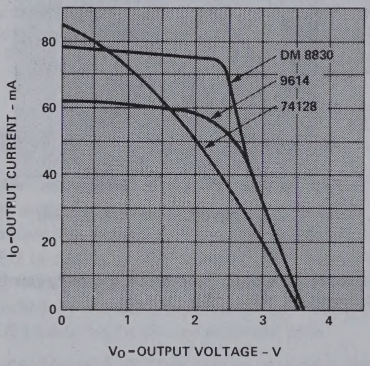


**Figure 7. Typical Output Characteristics of Reversing Line Drivers.**

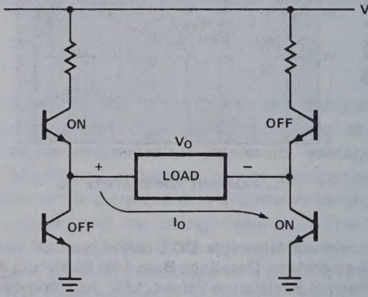


**Figure 8. Line Driver Equivalent Circuit.**

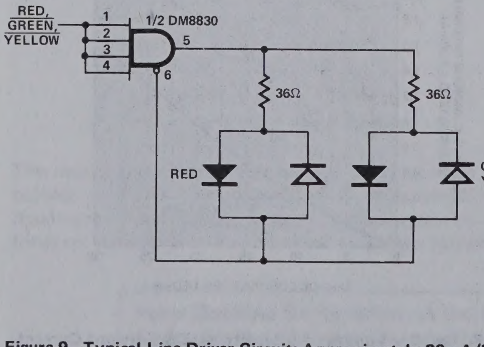
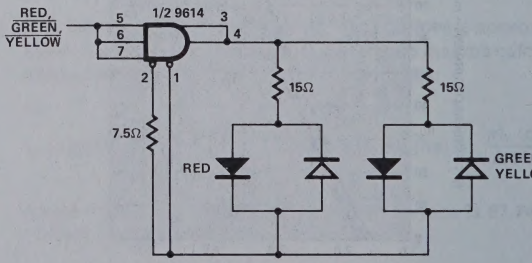
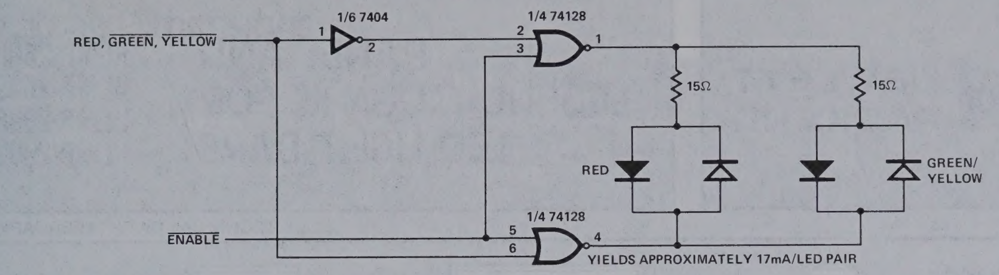


**Figure 9. Typical Line Driver Circuit; Approximately 20mA/LED Pair.**



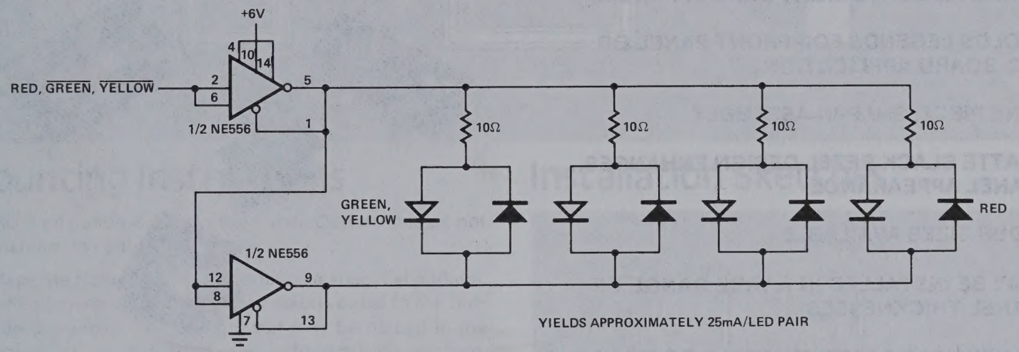
YIELDS APPROXIMATELY 20mA/RED LED
YIELDS APPROXIMATELY 25mA/YELLOW OR GREEN LED

**Figure 10. Techniques for Varying the Current of Each LED.**



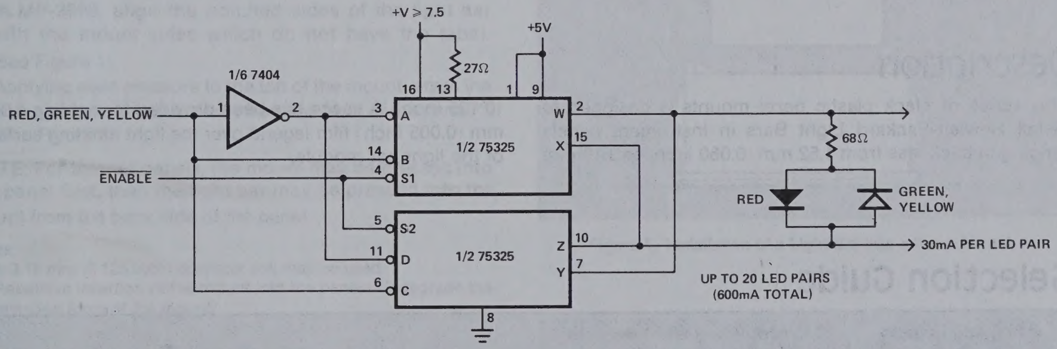
1/6 7404
1/4 74128
RED, $\overline{\text{GREEN}}$, $\overline{\text{YELLOW}}$
1
2
2
3
1
15Ω
15Ω
RED
GREEN/
YELLOW
1/4 74128
$\overline{\text{ENABLE}}$
5
6
4
YIELDS APPROXIMATELY 17mA/LED PAIR

**Figure 11. Tristate (Red, Green/Yellow, Off) Bicolor LED Driver.**



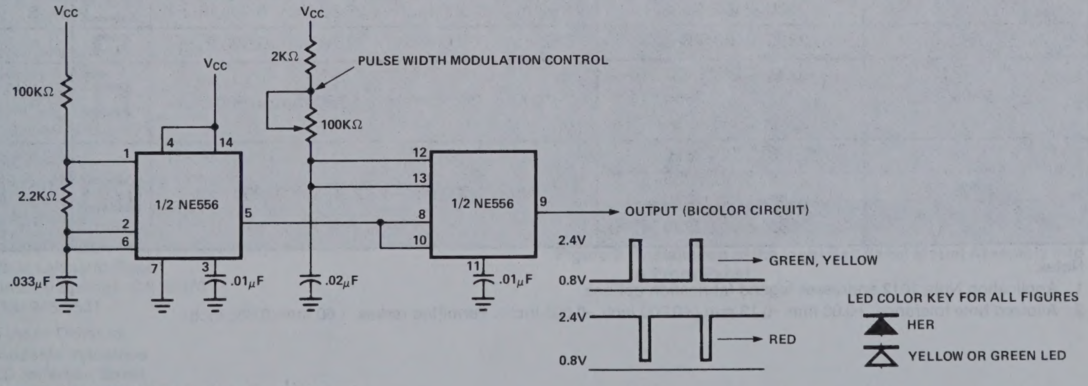
+6V
4
10
14
RED, $\overline{\text{GREEN}}$, $\overline{\text{YELLOW}}$
2
6
5
1/2 NE556
1
10Ω
10Ω
10Ω
10Ω
GREEN,
YELLOW
RED
1/2 NE556
12
8
9
7
13
YIELDS APPROXIMATELY 25mA/LED PAIR

**Figure 12. Use of Dual Timer to Drive Bicolor Light Bars**



+V ≥ 7.5
+5V
27Ω
1/6 7404
16
13
1
9
RED, $\overline{\text{GREEN}}$, $\overline{\text{YELLOW}}$
1
2
3
A
W
2
1/2 75325
X
15
14
B
4
S1
$\overline{\text{ENABLE}}$
68Ω
RED
GREEN,
YELLOW
5
S2
11
D
1/2 75325
Z
10
Y
7
6
C
8
30mA PER LED PAIR
UP TO 20 LED PAIRS
(600mA TOTAL)

**Figure 13. 75325 High Current Bicolor Driver**



$V_{CC}$
$V_{CC}$
$V_{CC}$
2KΩ
PULSE WIDTH MODULATION CONTROL
100KΩ
100KΩ
4
14
1
12
13
2.2KΩ
1/2 NE556
5
8
1/2 NE556
9
OUTPUT (BICOLOR CIRCUIT)
2
6
10
7
3
11
.033μF
.01μF
.02μF
.01μF
2.4V
0.8V
GREEN, YELLOW
2.4V
0.8V
RED
LED COLOR KEY FOR ALL FIGURES
HER
YELLOW OR GREEN LED

**Figure 14. Pulse Width Modulation Technique**

HEWLETT PACKARD

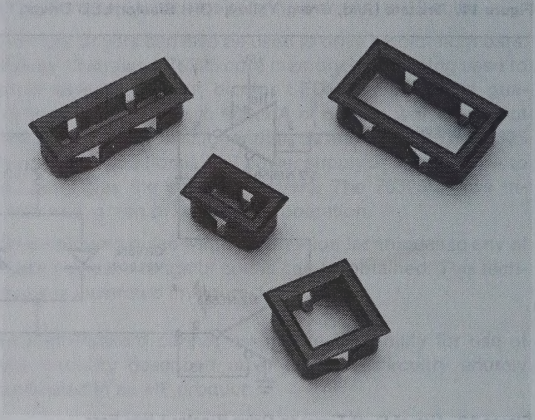
# PANEL AND LEGEND MOUNTS FOR LED LIGHT BARS

**HLMP-2598**
**HLMP-2599**
**HLMP-2898**
**HLMP-2899**

TECHNICAL DATA FEBRUARY 1982

## Features

- FIRMLY MOUNTS LIGHT BARS IN PANELS
- HOLDS LEGENDS FOR FRONT PANEL OR PC BOARD APPLICATIONS[1]
- ONE PIECE, SNAP-IN ASSEMBLY
- MATTE BLACK BEZEL DESIGN ENHANCES PANEL APPEARANCE
- FOUR SIZES AVAILABLE
- MAY BE INSTALLED IN A WIDE RANGE OF PANEL THICKNESSES
- PANEL HOLE EASILY PUNCHED OR MILLED



## Description

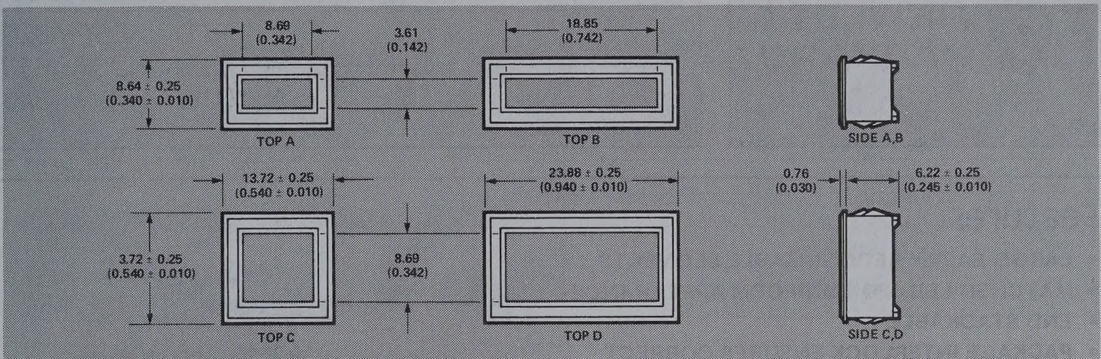
This series of black plastic bezel mounts is designed to install Hewlett-Packard Light Bars in instrument panels ranging in thickness from 1.52 mm (0.060 inch) to 3.18 mm (0.125 inch). A space has been provided for holding a 0.13 mm (0.005 inch) film legend over the light emitting surface of the light bar module.

## Selection Guide

| Panel and Legend Mount Part No. HLMP- | Corresponding Light Bar Module Part No. HLMP- | Panel Hole Installation Dimensions[2] | Package Outline | |
|---|---|---|---|---|
| 2598 | 2350, 2450, 2550 | 7.62 mm (0.300 inch) x 22.86 mm (0.900 inch) | ▭ | B |
| 2599 | 2300, 2400, 2500 | 7.62 mm (0.300 inch) x 12.70 mm (0.500 inch) | ▭ | A |
| 2898 | 2600, 2700, 2800<br>2655, 2755, 2855<br>2950, 2965 | 12.70 mm (0.500 inch) x 12.70 mm (0.500 inch) | □ | C |
| 2899 | 2620, 2720, 2820<br>2635, 2735, 2835<br>2670, 2770, 2870<br>2685, 2785, 2885 | 12.70 mm (0.500 inch) x 22.86 mm (0.900 inch) | ▭ | D |

Notes:
1. Application Note 1012 addresses legend fabrication options.
2. Allowed hole tolerance: +0.00 mm, -0.13 mm (+0.000 inch, -0.005 inch). Permitted radius: 1.60 mm (0.063 inch).

## Package Dimensions



NOTES: 1. DIMENSIONS IN MILLIMETRES (INCHES)
2. UNTOLERANCED DIMENSIONS ARE FOR REFERENCE ONLY.

## Mounting Instructions

1. Mill[3] or punch a hole in the panel. Deburr, but do not chamfer, the edges of the hole.
2. Place the front of the mount against a solid, flat surface. A film legend with outside dimensions equal to the outside dimensions of the light bar may be placed in the mount or on the light bar light emitting surface. Press the light bar into the mount until the tabs snap over the back of the light bar. (When inserting the HLMP-2898, align the notched sides of the light bar with the mount sides which do not have the tabs). (See Figure 1)
3. Applying even pressure to the top of the mount, press the entire assembly into the hole from the front of the panel.[4] (See Figure 2)

NOTE: For thinner panels, the mount may be pressed into the panel first, then the light bar may be pressed into the mount from the back side of the panel.

Notes:
3. A 3.18 mm (0.125 inch) diameter mill may be used.
4. Repetitive insertion of the mount into the panel will degrade the retention force of the mount.

## Suggested Punch Sources

Hole punches may be ordered from one of the following sources:

Danly Machine Corporation
Punchrite Division
15400 Brookpark Road
Cleveland, OH 44135
(216) 267-1444

Ring Division
The Producto Machine Company
Jamestown, NY 14701
(800) 828-2216

Porter Precision Products Company
12522 Lakeland Road
Santa Fe Springs, CA 90670
(213) 946-1531

Di-Acro Division
Houdaille Industries
800 Jefferson Street
Lake City, MN 55041
(612) 345-4571

## Installation Sketches

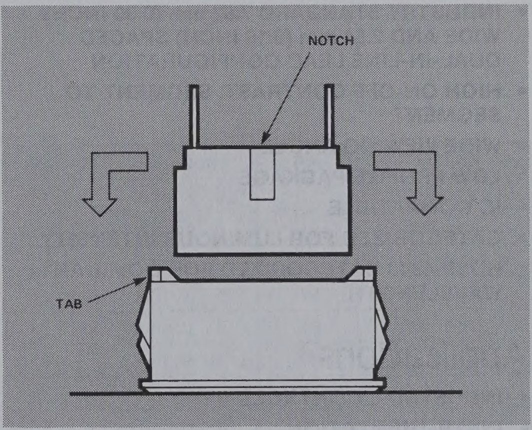


**Figure 1. Installation of a Light Bar into a Panel Mount**

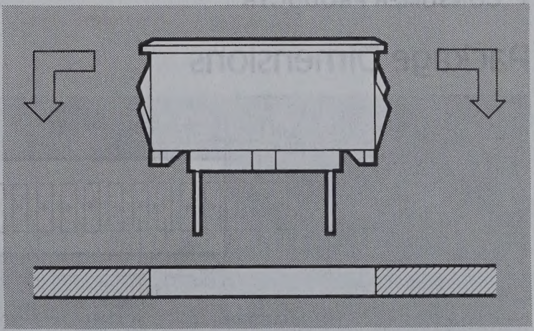


**Figure 2. Installation of the Light Bar/Panel Mount Assembly into a Front Panel**

HEWLETT PACKARD

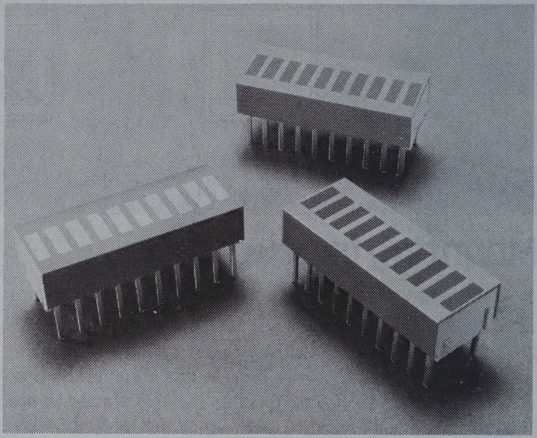
# 10-ELEMENT BAR GRAPH ARRAY

RED HDSP-4820
HIGH-EFFICIENCY RED HDSP-4830
YELLOW HDSP-4840

TECHNICAL DATA FEBRUARY 1982

## Features

- LARGE, EASILY RECOGNIZABLE SEGMENTS
- MATCHED LEDs FOR UNIFORM APPEARANCE
- END STACKABLE
- PACKAGE INTERLOCK ENSURES CORRECT ALIGNMENT
- RUGGED CONSTRUCTION
- INDIVIDUALLY ADDRESSABLE LEDs FOR CHOICE OF DRIVE
- INDUSTRY STANDARD 7.62 mm (0.30 INCH) WIDE AND 2.54 mm (0.10 INCH) SPACED DUAL-IN-LINE LEAD CONFIGURATION
- HIGH ON-OFF CONTRAST, SEGMENT TO SEGMENT
- WIDE VIEWING ANGLE
- LOW PROFILE PACKAGE
- IC COMPATIBLE
- CATEGORIZED FOR LUMINOUS INTENSITY
- HDSP-4840 CATEGORIZED FOR DOMINANT WAVELENGTH



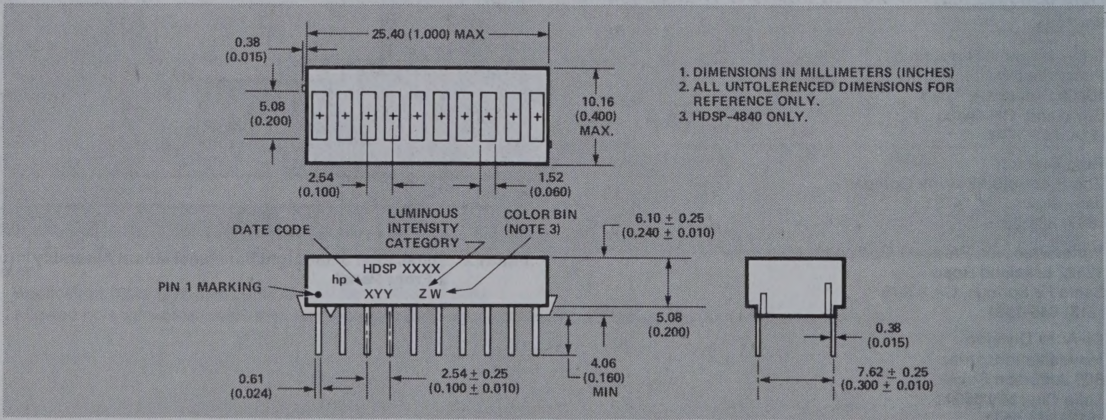
## Applications

- INDUSTRIAL CONTROLS
- INSTRUMENTATION
- OFFICE EQUIPMENT
- COMPUTER PERIPHERALS
- CONSUMER PRODUCTS

## Description

The HDSP-4820/-4830/-4840 are 10-element LED arrays designed to display information in easily recognizable bar graph form. The packages are end stackable and therefore capable of displaying long strings of information. Use of these bar graph arrays eliminates the alignment, intensity, and color matching problems associated with discrete LEDs. The anode and cathode of each LED segment are located at external pins allowing the user complete flexibility in designing drive circuits.

## Package Dimensions


25.40 (1.000) MAX
0.38 (0.015)
5.08 (0.200)
10.16 (0.400) MAX.
2.54 (0.100)
1.52 (0.060)
DATE CODE
LUMINOUS INTENSITY CATEGORY
COLOR BIN (NOTE 3)
6.10 ± 0.25 (0.240 ± 0.010)
PIN 1 MARKING
hp
HDSP XXXX
XYY
Z W
5.08 (0.200)
4.06 (0.160) MIN
0.61 (0.024)
2.54 ± 0.25 (0.100 ± 0.010)
0.38 (0.015)
7.62 ± 0.25 (0.300 ± 0.010)

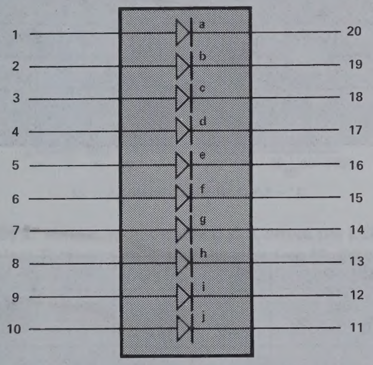
1. DIMENSIONS IN MILLIMETERS (INCHES)
2. ALL UNTOLERENCED DIMENSIONS FOR REFERENCE ONLY.
3. HDSP-4840 ONLY.

## Absolute Maximum Ratings

| Parameter | HDSP-4820 | | HDSP-4830<br>HDSP-4840 | |
|---|---|---|---|---|
| Average Power Dissipation per LED | $T_A = 60° C$ | 65 mW | $T_A = 50° C$ | 81 mW |
| Peak Forward Current per LED | | 150 mA[1] | | 60 mA[2] |
| DC Forward Current per LED | | 25 mA[3] | | 20 mA[4] |
| Operating Temperature Range | -40° C to +85° C | | | |
| Storage Temperature Range | -40° C to +85° C | | | |
| Reverse Voltage per LED | 3.0V | | | |
| Lead Soldering Temperature [1.59 mm (1/16 inch) below seating plane][5] | 260° C for 3 sec. | | | |

Notes:
1. See Figure 1 to establish pulsed operating conditions.
2. See Figure 6 to establish pulsed operating conditions.
3. Derate maximum DC current above $T_A = 60° C$ at 0.65 mA/° C per LED. This derating assumes worst case $R_{\Theta JA} = 600° C/W/LED$. With an improved thermal design, operation at higher temperatures without derating is possible. See Figure 2.
4. Derate maximum DC current above $T_A = 50° C$ at 0.40 mA/° C per LED. This derating assumes worst case $R_{\Theta JA} = 600° C/W/LED$. With an improved thermal design, operation at higher temperatures without derating is possible. See Figure 7.
5. Clean only in water, isopropanol, ethanol, Freon TF or TE (or equivalent) and Genesolv DI-15 or DE-15 (or equivalent).

## Internal Circuit Diagram



HDSP - 4820
HDSP - 4830
HDSP - 4840

| Pin | Function | Pin | Function |
|---|---|---|---|
| 1 | Anode a | 11 | Cathode j |
| 2 | Anode b | 12 | Cathode i |
| 3 | Anode c | 13 | Cathode h |
| 4 | Anode d | 14 | Cathode g |
| 5 | Anode e | 15 | Cathode f |
| 6 | Anode f | 16 | Cathode e |
| 7 | Anode g | 17 | Cathode d |
| 8 | Anode h | 18 | Cathode c |
| 9 | Anode i | 19 | Cathode b |
| 10 | Anode j | 20 | Cathode a |

# Electrical/Optical Characteristics at $T_A = 25°C$

**RED HDSP-4820**

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity per LED (Unit Average)[1] | $I_F$ | $I_F = 20$ mA | 250 | 880 | | µcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 655 | | nm |
| Dominant Wavelength[2] | $\lambda_d$ | | | 645 | | nm |
| Forward Voltage per LED | $V_F$ | $I_F = 20$ mA | | 1.6 | 2.0 | V |
| Reverse Current per LED | $I_R$ | $V_R = 3V$ | | | 100 | µA |
| Temperature Coefficient $V_F$ per LED | $\Delta V_F/°C$ | | | -2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R_{\Theta J\text{-}PIN}$ | | | 300 | | °C/W/ LED |

**HIGH-EFFICIENCY RED HDSP-4830**

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity per LED (Unit Average)[1] | $I_V$ | $I_F = 10$ mA | 600 | 1700 | | µcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 635 | | nm |
| Dominant Wavelength[2] | $\lambda_d$ | | | 626 | | nm |
| Forward Voltage per LED | $V_F$ | $I_F = 20$ mA | | 2.1 | 2.5 | V |
| Reverse Current per LED | $I_R$ | $V_R = 3V$ | | | 100 | µA |
| Temperature Coefficient $V_F$ per LED | $\Delta V_F/°C$ | | | -2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R_{\Theta J\text{-}PIN}$ | | | 300 | | °C/W/ LED |

**YELLOW HDSP-4840**

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity per LED (Unit Average)[1] | $I_V$ | $I_F = 10$ mA | 600 | 1200 | | µcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 583 | | nm |
| Dominant Wavelength[2,3] | $\lambda_d$ | | 581 | 585 | 592 | nm |
| Forward Voltage per LED | $V_F$ | $I_F = 20$ mA | | 2.2 | 2.5 | V |
| Reverse Current per LED | $I_R$ | $V_R = 3V$ | | | 100 | µA |
| Temperature Coefficient $V_F$ per LED | $\Delta V_F/°C$ | | | -2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R_{\Theta J\text{-}PIN}$ | | | 300 | | °C/W/ LED |

Notes:

1. The bar graph arrays are categorized for luminous intensity. The category is designated by a letter located on the side of the package.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and is that single wavelength which defines the color of the device.
3. The HDSP-4840 yellow bar graph arrays are categorized by dominant wavelength with the category designated by a number adjacent to the intensity category letter.

# HDSP-4820

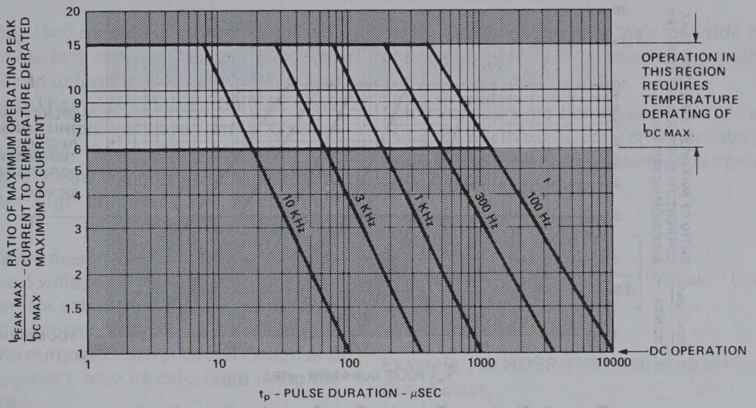


Figure 1. Maximum Tolerable Peak Current vs. Pulse Duration

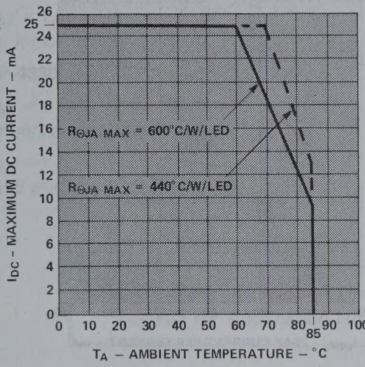


Figure 2. Maximum Allowable D.C. Current per LED vs. Ambient Temperature. Deratings based on Maximum Allowable Thermal Resistance, LED Junction-to-Ambient on a per LED basis. $T_{JMAX}$ = 100° C

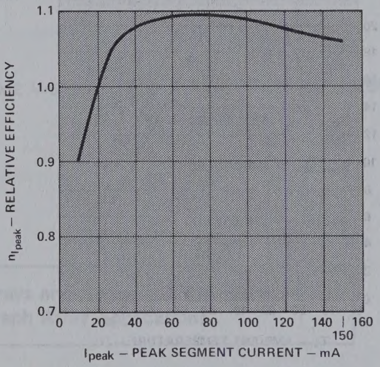


Figure 3. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current

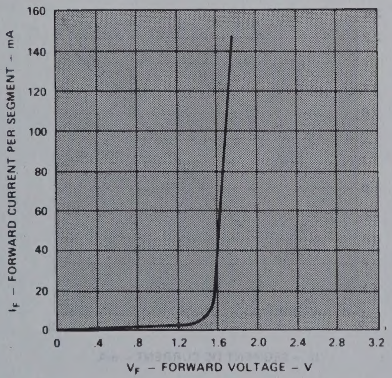


Figure 4. Forward Current vs. Forward Voltage

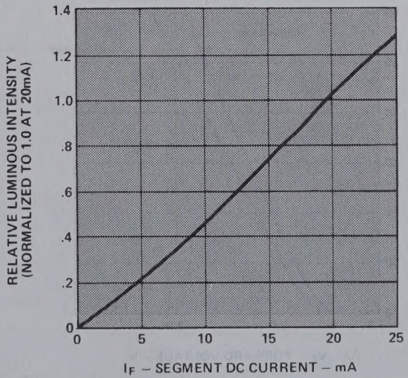


Figure 5. Relative Luminous Intensity vs. D.C. Forward Current

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

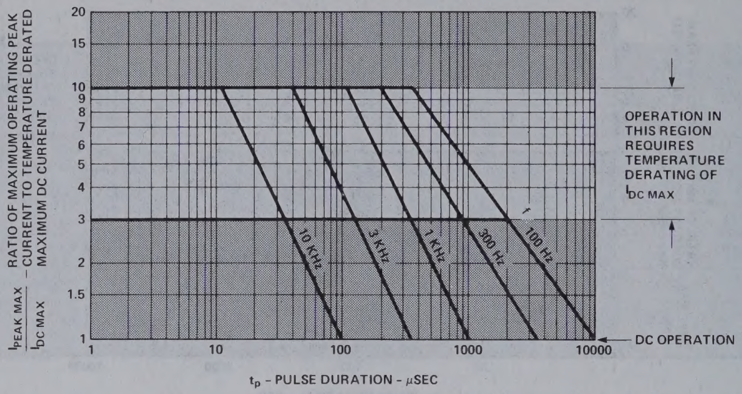


Figure 6. Maximum Tolerable Peak Current vs. Pulse Duration

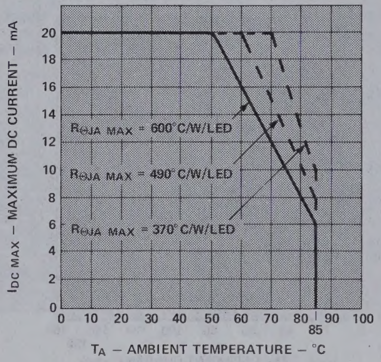


Figure 7. Maximum Allowable D.C. Current per LED vs. Ambient Temperature. Deratings Based on Maximum Allowable Thermal Resistance Values, LED Junction-to-Ambient on a per LED basis. $T_{J\ MAX} = 100°C$

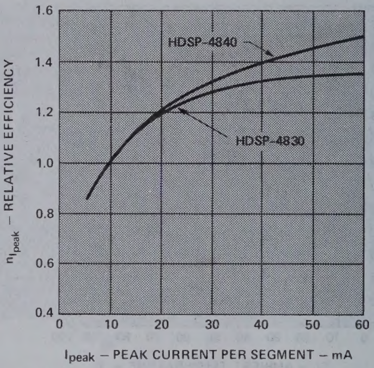


Figure 8. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current

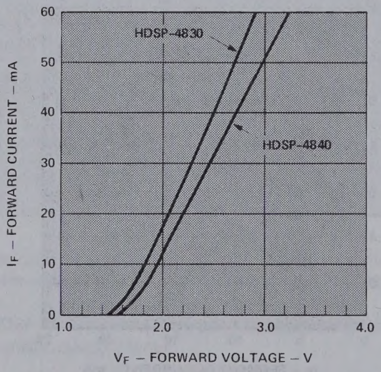


Figure 9. Forward Current vs. Forward Voltage Characteristics

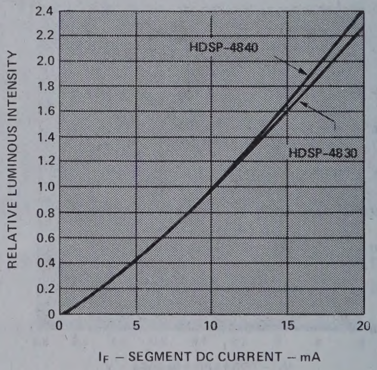


Figure 10. Relative Luminous Intensity vs. D.C. Forward Current

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

# Electrical

The HDSP-4820/-4830/-4840 series of bar graph arrays are composed of ten light emitting diodes. The light from each LED is optically stretched to form individual elements. The diodes in the HDSP-4820 bar graph utilize a Gallium Arsenide Phosphide (GaAsP) epitaxial layer on a Gallium Arsenide (GaAs) Substrate. The HDSP-4830/-4840 bar graphs utilize a GaAsP epitaxial layer on a GaP substrate to produce the brighter high-efficiency red and yellow displays.

These display devices are designed to allow strobed operation. The typical forward voltage values, scaled from Figure 4 or 9, should be used for calculating the current limiting resistor value and typical power dissipation. Expected maximum $V_F$ values, for the purpose of driver circuit design and maximum power dissipation, may be calculated using the following $V_{F\ MAX}$ models.

**HDSP-4820**

$V_{F\ MAX} = 1.55V + I_{PEAK}\ (7\Omega)$
For: $I_{PEAK} \geq 5$ mA

**HDSP-4830/-4840**

$V_{F\ MAX} = 1.75V + I_{PEAK}\ (38\Omega)$
For $I_{PEAK} \geq 20$ mA

$V_{F\ MAX} = 1.6V + I_{DC}\ (45\Omega)$
For: $5\text{ mA} \leq I_{DC} \leq 20$ mA

Refresh rates of 1 KHz or faster provide the most efficient operation resulting in the maximum possible time averaged luminous intensity.

The time averaged luminous intensity may be calculated using the relative efficiency characteristic shown in Figures 3 and 8. The time averaged luminous intensity at $T_A = 25°$ C is calculated as follows:

$$I_{V\ TIME\ AVG} = \left[\frac{I_{F\ AVG}}{I_{F\ SPEC\ AVG}}\right](\eta I_{PEAK})\ (I_{V\ SPEC})$$

Example: For HDSP-4830 operating at $I_{PEAK} = 50$ mA, 1 of 4 Duty Factor

$$\eta I_{PEAK} = 1.35\ (\text{at } I_{PEAK} = 50\text{ mA})$$

$$I_{V\ TIME\ AVG} = \left[\frac{12.5\text{ mA}}{10\text{ mA}}\right](1.35)\ (1700\ \mu\text{cd}) = 2869\ \mu\text{cd}$$

**For Further Information Concerning Bar Graph Arrays and Suggested Drive Circuits, Consult HP Application Note 1007 Entitled "Bar Graph Array Applications".**

HEWLETT PACKARD

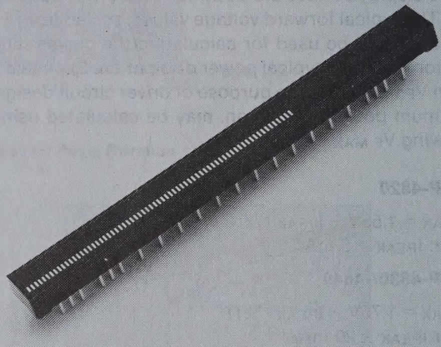
# 101 ELEMENT BAR GRAPH ARRAY

## RED HDSP-8820

TECHNICAL DATA FEBRUARY 1982

## Features

- **EXCELLENT RESOLUTION (1%)**
- **EXCELLENT ELEMENT APPEARANCE 1.52 mm (0.060") WIDE, EASILY RECOGNIZABLE ELEMENTS**
  **Matched LEDs for Uniformity**
  **Excellent Element Alignment**
  **Easy Readability at 1 Meter**
- **SINGLE-IN-LINE PACKAGE DESIGN**
  **Sturdy Leads on Industry Standard 2.54mm (0.100") Centers**
  **Environmentally Rugged Package**
  **Common Cathode Configuration**
- **LOW POWER REQUIREMENTS**
  **As low as 1.0 - 1.5 mA average per element depending on Peak Current Levels.**
- **SUPPORT ELECTRONICS**
  **Easy Interface with Microprocessors**



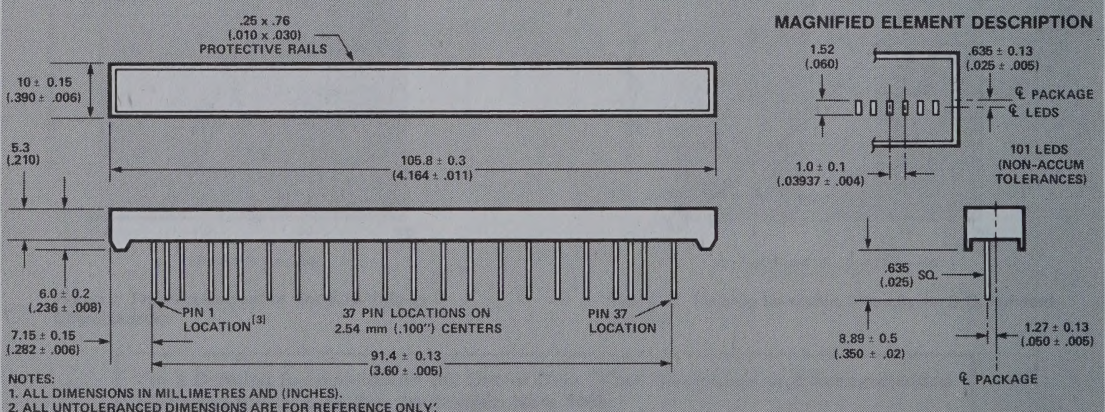
## Description

The HDSP-8820 is a 101-element monolithic LED linear array. It is designed to display information in easily recognizable bar graph or position indicator form. The device utilizes GaAsP LED chips assembled on a PC board which is enclosed in a red polycarbonate cover with an epoxy backfill seal. The common cathode chips are addressed via 22 single-in-line pins extending from the back side of the package.

## Applications

- **INDUSTRIAL PROCESS CONTROL SYSTEMS**
- **EDGEWISE PANEL METERS**
- **INSTRUMENTATION**
- **POSITION INDICATORS**
- **FLUID LEVEL INDICATORS**

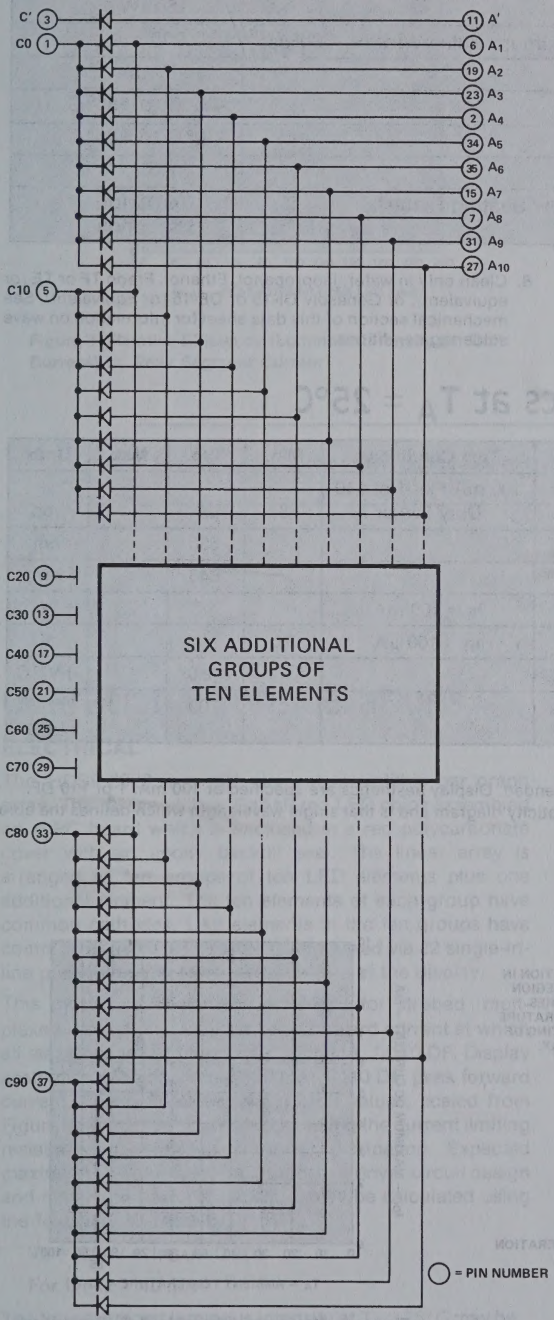
## Package Dimensions (1, 2)



.25 x .76
(.010 x .030)
PROTECTIVE RAILS
10 ± 0.15
(.390 ± .006)
5.3
(.210)
105.8 ± 0.3
(4.164 ± .011)
6.0 ± 0.2
(.236 ± .008)
7.15 ± 0.15
(.282 ± .006)
PIN 1
LOCATION [3]
37 PIN LOCATIONS ON
2.54 mm (.100") CENTERS
PIN 37
LOCATION
91.4 ± 0.13
(3.60 ± .005)
MAGNIFIED ELEMENT DESCRIPTION
1.52
(.060)
.635 ± 0.13
(.025 ± .005)
℄ PACKAGE
℄ LEDS
1.0 ± 0.1
(.03937 ± .004)
101 LEDS
(NON-ACCUM
TOLERANCES)
.635
(.025) SQ.
8.89 ± 0.5
(.350 ± .02)
1.27 ± 0.13
(.050 ± .005)
℄ PACKAGE

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES).
2. ALL UNTOLERANCED DIMENSIONS ARE FOR REFERENCE ONLY.
3. PIN 1 IDENTIFIED BY INK DOT ADJACENT TO LEAD AND HP PART NUMBER ON BACK OF PACKAGE.

## Internal Circuit Diagram (4, 5)


C' 3
C0 1
11 A'
6 A1
19 A2
23 A3
2 A4
34 A5
35 A6
15 A7
7 A8
31 A9
27 A10
C10 5
C20 9
C30 13
C40 17
C50 21
C60 25
C70 29
C80 33
C90 37
SIX ADDITIONAL GROUPS OF TEN ELEMENTS
= PIN NUMBER

NOTES:
4. ELEMENT LOCATION NUMBER = COMMON CATHODE NUMBER + ANODE NUMBER. FOR EXAMPLE, ELEMENT 83 IS OBTAINED BY ADDRESSING C80 AND A3.
5. A' AND C' ARE ANODE AND CATHODE OF ELEMENT ZERO.

## Device Pin Description

| PIN LOCATION | FUNCTION |
|---|---|
| 1 | C0 |
| 2 | A4 |
| 3 | C'(5) |
| 4 | No Pin • |
| 5 | C10 |
| 6 | A1 |
| 7 | A8 |
| 8 | No Pin |
| 9 | C20 |
| 10 | No Pin |
| 11 | A'(5) |
| 12 | No Pin |
| 13 | C30 |
| 14 | No Pin |
| 15 | A7 |
| 16 | No Pin |
| 17 | C40 |
| 18 | No Pin |
| 19 | A2 |
| 20 | No Pin |
| 21 | C50 |
| 22 | No Pin |
| 23 | A3 |
| 24 | No Pin |
| 25 | C60 |
| 26 | No Pin |
| 27 | A10 |
| 28 | No Pin |
| 29 | C70 |
| 30 | No Pin |
| 31 | A9 |
| 32 | No Pin |
| 33 | C80 |
| 34 | A5 |
| 35 | A6 |
| 36 | No Pin |
| 37 | C90 |

# Absolute Maximum Ratings

| Parameter | HDSP-8820 |
|---|---|
| Average Power per Element, $T_A = 25°C$ | 15 mW |
| Peak Forward Current per Element, $T_A = 25°C$ (Maximum Pulse Width = 300 μs)[6] | 200 mA |
| Average Forward Current per Element, $T_A = 25°C$[7] | 7 mA |
| Operating Temperature Range | -40°C to +85°C |
| Storage Temperature Range | -40°C to +85°C |
| Reverse Voltage per Element | 5V |
| Lead Solder Temperature, 1.59 mm (1/16 inch) Below Seating Plane[8] | 260°C for 3 seconds |

NOTE:

6. See Figure 1 to establish pulsed operating conditions.
7. Derate maximum average forward current above $T_A = 70°C$ at 0.16 mA/°C per element. See Figure 2.
8. Clean only in water, Isopropanol, Ethanol. Freon TF or TE (or equivalent), or Genesolv DI-15 or DE-15 (or Equivalent). See mechanical section of this data sheet for information on wave soldering conditions.

# Electrical/Optical Characteristics at $T_A = 25°C$

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Time averaged Luminous Intensity per Element (Unit average)[9] | $I_V$ | 100 mA Pk.: 1 of 110 Duty Factor | 8 | 20 | | μcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 655 | | nm |
| Dominant Wavelength[10] | $\lambda_d$ | | | 640 | | nm |
| Forward Voltage per Element | $V_F$ | $I_F = 100$ mA | | 1.7 | 2.1 | V |
| Reverse Voltage per Element | $V_R$ | $I_R = 100$ μA | 3.0 | | | V |
| Temperature Coefficient $V_F$ per Element | $\Delta V_F/°C$ | | | -2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R\Theta_{J-PIN}$ | | | 700 | | °C/W/LED |

Notes:

9. Operation at peak currents of less than 15 mA is not recommended. Display aesthetics are specified at 100 mA, 1 of 110 DF.
10. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and is that single wavelength which defines the color of the device.

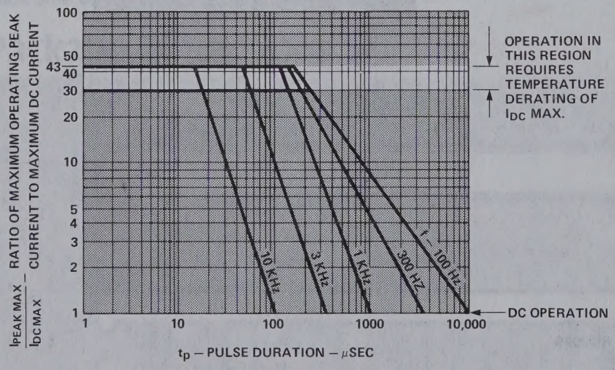


**Figure 1. Maximum Tolerable Peak Current vs. Pulse Duration**

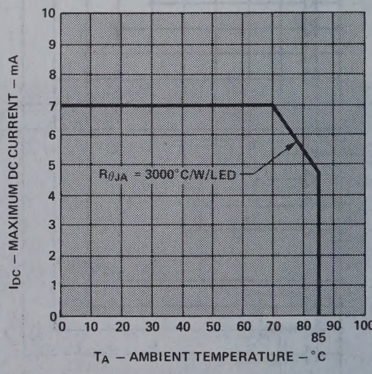


**Figure 2. Maximum Allowable D.C. Current per LED vs. Ambient Temperature. Deratings based on Maximum Allowable Thermal Resistance, LED Junction-to-Ambient on a per LED basis. $T_{JMAX} = 115°C$**

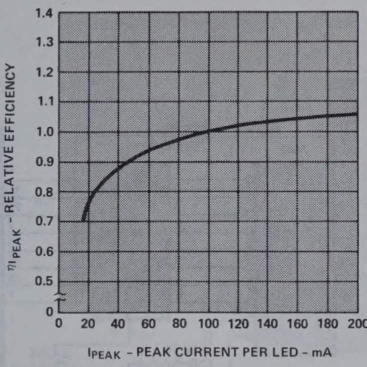


**Figure 3. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current**

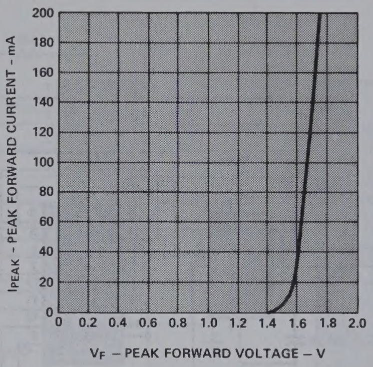


**Figure 4. Forward Current vs. Forward Voltage**

**For A Detailed Explanation on the Use of Data Sheet Information, See Application Note 1005.**

# Operational Considerations

## ELECTRICAL

The HDSP-8820 is a 101 element monolithic bar graph array. The device utilizes GaAsP red LED chips assembled on a PC board which is enclosed in a red polycarbonate cover with an epoxy backfill seal. The linear array is arranged as ten groups of ten LED elements plus one additional element. The ten elements of each group have common cathodes. Like elements in the ten groups have common anodes. The device is addressed via 22 single-in-line pins extending from the back side of the display.

This display is designed specifically for strobed (multiplexed) operation. Minimum peak forward current at which all elements will be illuminated is 15 mA, 1/110 DF. Display aesthetics are specified at 100 mA, 1/110 DF, peak forward current. The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor value and typical power dissipation. Expected maximum $V_F$ values, for the purpose of driver circuit design and maximum power dissipation, may be calculated using the following $V_F$ model:

$$V_F = 2.02V + I_{PEAK}\,(0.8\Omega)$$

For $I_{PEAK} > 40$ mA

The time averaged luminous intensity at $T_A = 25°$ C may be calculated using:

$$I_V \text{ Time Avg.} = \left[\frac{I_{F-AVG}}{I_{F-SPEC-AVG}}\right] \bullet \eta I_{PEAK} \bullet I_{V-SPEC}$$

where $\eta$, relative efficiency, may be determined from Figure 3.

The circuit in Figure 5 displays binary weighted input in bar graph form with 101 bit resolution. Central to the design is a 74390 100 count decade counter. The "1's" output from the counter drives the display element anodes through a 7442 1 of 10 BCD decoder. Sprague UDN 2585 drivers boost peak current. The "10's" output from the counter drives the group cathodes through a 74145 1 of 10 BCD decoder. A 74393 seven bit binary counter follows the decade counter and is reset after each 100 counts. A 74LS85 binary comparator looks at inputs from the binary counter and external circuitry. The comparator output disables the display when the binary count exceeds the binary weighted input. The first display element is DC driven.

The circuit in Figure 6 uses the HDSP-8820 as a 100 bit position indicator. Two BCD input words define the position of the illuminated element. Display duty factor, 1/100, is controlled by the $\overline{\text{ENABLE}}$ signal.

## MECHANICAL

Suitable conditions for wave soldering depend on the specific kind of equipment and procedure used. A cool down period after flow solder and before flux rinse is recommended. For more information, consult the local Hewlett-Packard Sales Office or Hewlett-Packard Optoelectronics, Palo Alto, California.

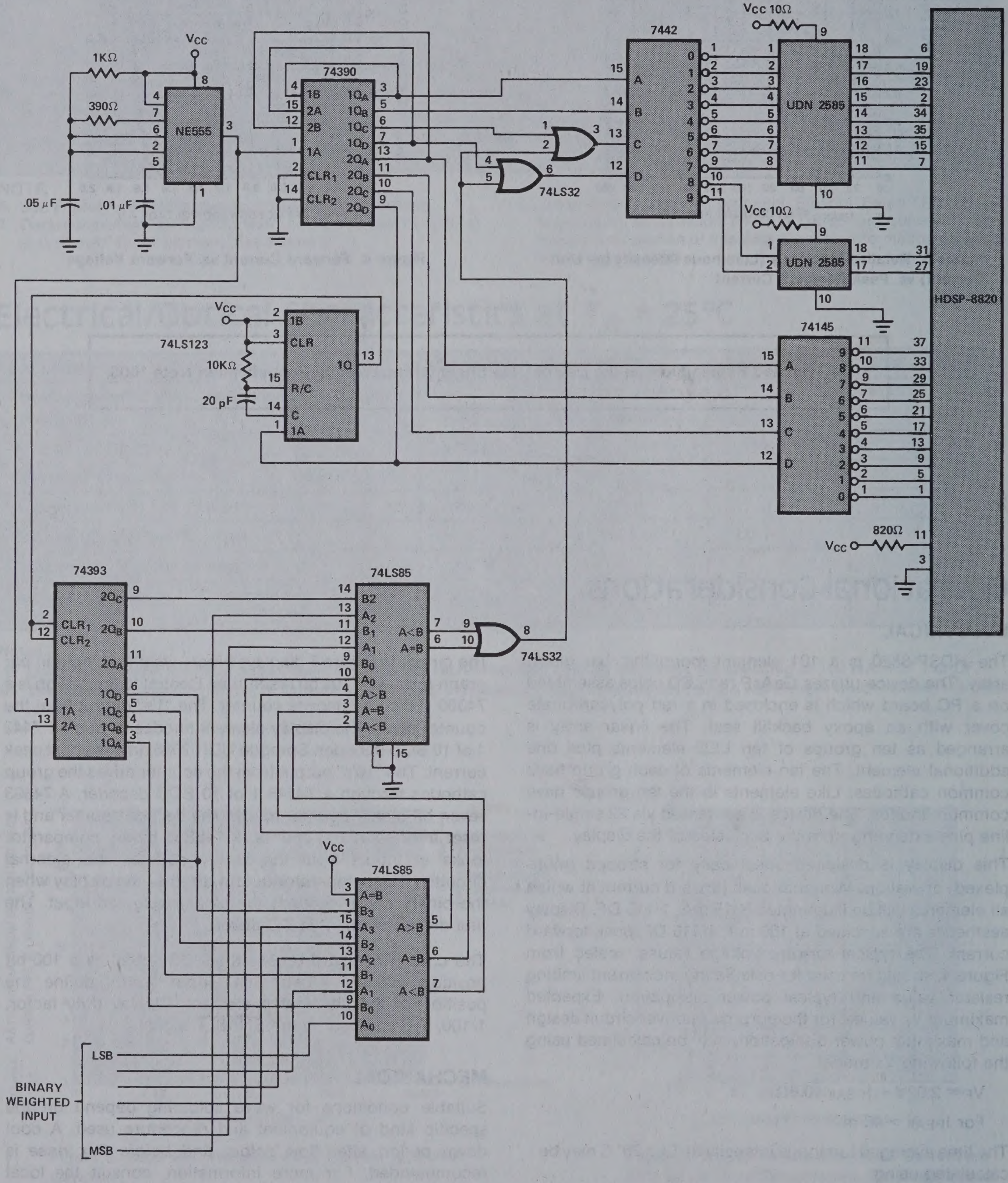

VCC
1KΩ
390Ω
NE555
.05 μF
.01 μF
74390
1B
2A
2B
1A
CLR1
CLR2
1QA
1QB
1QC
1QD
2QA
2QB
2QC
2QD
74LS32
7442
A
B
C
D
VCC 10Ω
UDN 2585
VCC 10Ω
UDN 2585
HDSP-8820
74LS123
1B
CLR
R/C
C
1A
1Q
10KΩ
20 pF
74145
820Ω
VCC
74393
CLR1
CLR2
1A
2A
2QC
2QB
2QA
1QD
1QC
1QB
1QA
74LS85
B2
A2
B1
A1
B0
A0
A>B
A=B
A<B
74LS32
VCC
74LS85
A=B
B3
A3
B2
A2
B1
A1
B0
A0
A>B
A=B
A<B
LSB
BINARY
WEIGHTED
INPUT
MSB

Figure 5. 101 Element Bar Graph

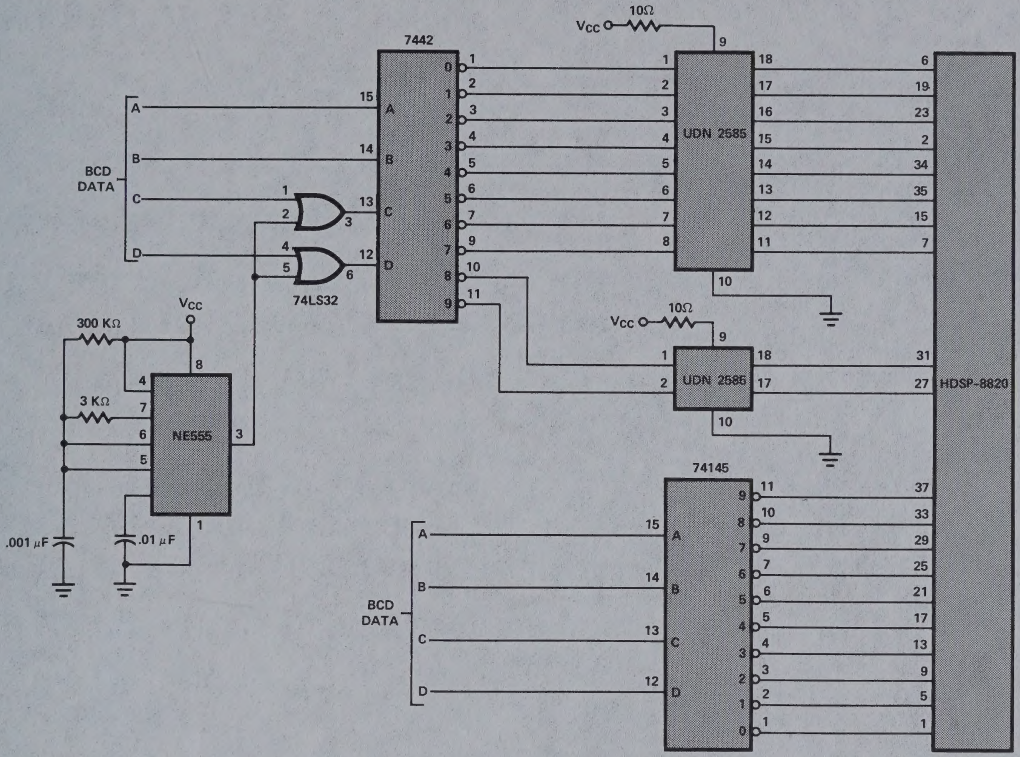
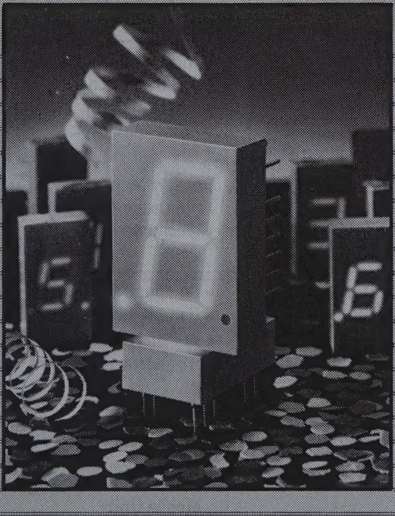

BCD DATA
A
B
C
D
74LS32
7442
Vcc
10Ω
UDN 2585
UDN 2585
HDSP-8820
300 KΩ
3 KΩ
NE555
.001 µF
.01 µF
BCD DATA
A
B
C
D
74145

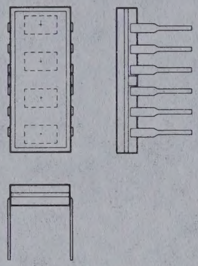
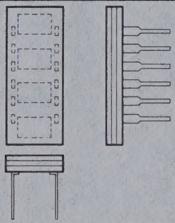
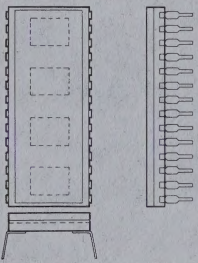
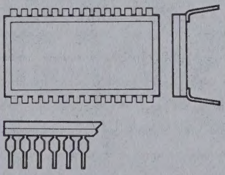
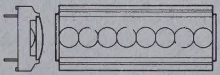
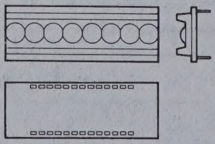
Figure 6. 100 Element Position Indicator

# Solid State Displays

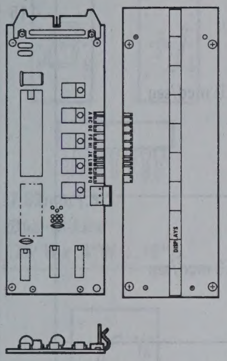
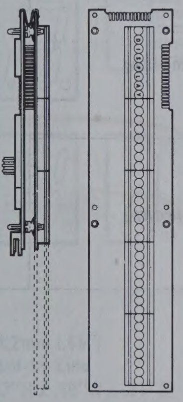
- *Selection Guide .............. 38*
- *Alphanumeric Displays*
- *Alphanumeric Display Systems*
- *Red, High Efficiency Red, Yellow and Green Seven Segment Displays*
- *Standard Red Numeric and Hexadecimal Dot Matrix*
- *High Efficiency Red, Yellow and Green Numeric and Hexadecimal Displays*
- *Red Seven Segment Displays*



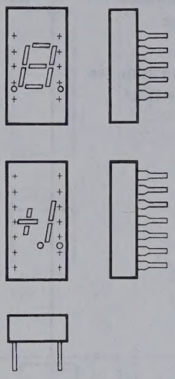
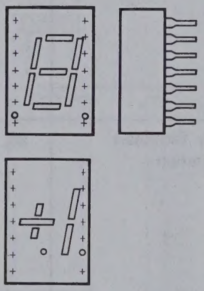
# Alphanumeric LED Displays

| Device | | Description | Package/ Color | Application | Page No. |
|---|---|---|---|---|---|
|  | HDSP-2000 | 3.7mm (.15") 5 x 7 Four Character Alphanumeric | 12 Pin Ceramic 7.62mm (.3") DIP/Red, Red Glass Contrast Filter | • Computer Terminals<br>• Business Machines<br>• Medical Instruments<br>• Portable, Hand-held or mobile data entry, read-out or communications<br>For further information see Application Notes 966 and 1001. | 46 |
| | HDSP-2001 | | 12 Pin Ceramic 7.62mm (.3") DIP/Yellow, Untinted Glass Lens | | |
| | HDSP-2002 | | 12 Pin Ceramic 7.62mm (.3") DIP/High Eff. Red, Untinted Glass Lens | | |
| | HDSP-2010 | Extended Temperature to $T_A = -40^\circ C$ 3.7mm (.15") 5 x 7 Four Character Alphanumeric | 12 Pin Ceramic 7.62mm (.3") DIP/Red, Red Glass Contrast Filter | • Extended temperature applications requiring high reliability.<br>• I/O Terminals<br>• Avionics<br>For further information see Application Notes 966 and 1001. | 52 |
| | 2010TXV | TXV Hi Rel Screened | | | |
|  | HDSP-2300 | 4.87mm (.19") 5 x 7 Four Character Alphanumeric | 12 Pin Ceramic 6.35mm (.25") DIP/Red, Low Power | • Avionics<br>• Military Equipment<br>• Ground Support, Cockpit, Shipboard systems<br>• Medical Equipment<br>• Industrial and Process control<br>• Computer Peripherals and Terminals<br>• Outdoor Metering Equipment<br>• Computer Base Mobile Units<br>• High Brightness Ambient Systems<br>For further information see Application Notes 966 and 1001. | 56 |
| | HDSP-2301 | | 12 Pin Ceramic 6.35mm (.25") DIP/Yellow, High Brightness | | |
| | HDSP-2302 | | 12 Pin Ceramic 6.35mm (.25") DIP/High Eff. Red, High Brightness | | |
|  | HDSP-2490 | 6.9mm (.27") 5 x 7 Four Character Alphanumeric | 28 Pin Ceramic 15.24mm (.6") DIP/ Red | | 62 |
| | HDSP-2491 | | 28 Pin Ceramic 15.24mm (.6") DIP/ Yellow, High Brightness | | |
| | HDSP-2492 | | 28 Pin Ceramic 15.24mm (.6") DIP/ High Eff. Red, High Brightness | | |
|  | 5082-7100 | 6.9mm (.27") 5x7 Three Digit Alphanumeric | 22 Pin Ceramic 15.2mm (.6") DIP Untinted Glass Lens | General Purpose Market<br>• Business Machines<br>• Calculators<br>• Solid State CRT<br>• High Reliability Applications<br>For further information ask for Application Note 931 on Alphanumeric Displays. | 68 |
| | 5082-7101 | 6.9mm (.27") 5x7 Four Digit Alphanumeric | 28 Pin Ceramic 15.2mm (.6") DIP Untinted Glass Lens | | |
| | 5082-7102 | 6.9mm (.27") 5x7 Five Digit Alphanumeric | 36 Pin Ceramic 15.2mm (.6") DIP Untinted Glass Lens | | |
|  | HDSP-6504 | 3.8mm (.15") Sixteen Segment Four Character Alphanumeric | 22 Pin 15.2mm (.6") DIP | • Computer Terminals<br>• Hand Held Instruments<br>• In-Plant Control Equipment<br>• Diagnostic Equipment | 72 |
| | HDSP-6508 | 3.8mm (.15") Sixteen Segment Eight Character Alphanumeric | 26 Pin 15.2mm (.6") DIP | | |
|  | HDSP-6300 | 3.56mm (.14") Sixteen Segment Eight Character Alphanumeric | 26 Pin 15.2mm (.6") DIP | • Computer Peripherals and Terminals<br>• Computer Base Emergency Mobile Units<br>• Automotive Instrument Panels<br>• Desk Top Calculators<br>• Hand-held Instruments<br>For further information ask for Application Note 931. | 78 |

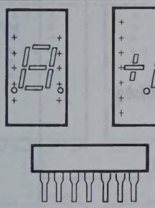
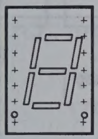
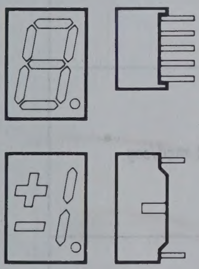
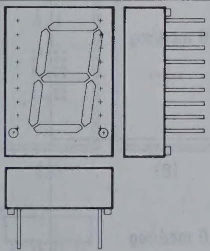
# Alphanumeric Display Systems

| Device | | Description | Package | Application | Page No. |
|---|---|---|---|---|---|
|  | HDSP-2416 | Single-Line 16 Character Display Panel Utilizing the HDSP-2000 Display | 162.56mm (6.4") L x 58.42mm (2.3") H x 7.11mm (.28") D | • Data Entry Terminals<br>• Instrumentation<br>For further information see Application Note 1001. | 83 |
| | HDSP-2424 | Single-Line 24 Character Display Panel Utilizing the HDSP-2000 Display. | | | |
| | HDSP-2432 | Single-Line 32 Character Display Panel Utilizing the HDSP-2000 Display | | | |
| | HDSP-2440 | Single-Line 40 Character Display Panel Utilizing the HDSP-2000 Display | 177.80mm (7.0") L x 58.42mm (2.3") H x 7.11mm (.28") D | | |
| | HDSP-2470 | HDSP-2000 Display Interface Incorporating a 64 Character ASCII Decoder | 171.22mm (6.74") L x 58.42mm (2.3") H x 16.51mm (.65") D | | |
| | HDSP-2471 | HDSP-2000 Display Interface Incorporating a 128 Character ASCII Decoder | | | |
| | HDSP-2472 | HDSP-2000 Display Interface without ASCII Decoder. Instead, a 24 Pin Socket is Provided to Accept a Custom 128 Character Set from a User Programmed 1K x 8 PROM | | | |
|  | HDSP-8716 | Single-line 16 Character Alphanumeric Display System Utilizing the HDSP-6508 Display | 167.64mm (6.6") L x 58.42mm (2.3") H x 33mm (1.3") D | • Data Entry Terminals<br>• Instrumentation | 95 |
| | HDSP-8724 | Single-line 24 Character Alphanumeric Display System Utilizing the HDSP-6508 Display | | | |
| | HDSP-8732 | Single-line 32 Character Alphanumeric Display System Utilizing the HDSP-6508 Display | 218.44mm (8.6") L x 58.42mm (2.3") H x 33mm (1.3") D | | |
| | HDSP-8740 | Single-line 40 Character Alphanumeric Display System Utilizing the HDSP-6508 Display | 269.24mm (10.6") L x 58.42mm (2.3") H x 33mm (1.3") D | | |

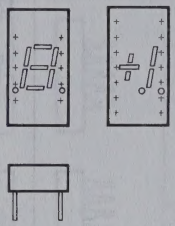
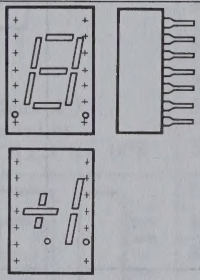
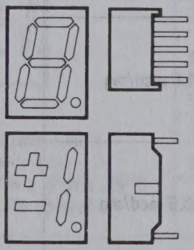
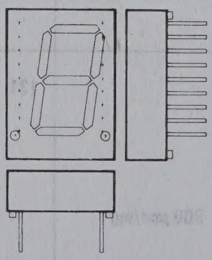
# Red, High Efficiency Red, Yellow and Green Seven Segment LED Displays

| Package | Device | Description | Typical $I_V$ @ 20mA | Page No. |
|---|---|---|---|---|
|  7.62mm (.3")<br>Dual-In-Line<br>.75"H x .4"W x .18"D | 5082-7610 | High Efficiency Red, Common Anode, LHDP | 3.0 mcd/seg | 115 |
| | 5082-7611 | High Efficiency Red, Common Anode, RHDP | | |
| | 5082-7613 | High Efficiency Red, Common Cathode, RHDP | | |
| | 5082-7616 | 7.11mm (.29") High Efficiency Red, Universal Polarity Overflow Indicator RHDP | | |
| | 5082-7620 | Yellow, Common Anode LHDP | 2.3 mcd/seg | |
| | 5082-7621 | Yellow, Common Anode RHDP | | |
| | 5082-7623 | Yellow, Common Cathode, RHDP | | |
| | 5082-7626 | 7.11mm (.29") Yellow, Universal Polarity and Overflow Indicator RHDP | | |
| | 5082-7630 | Green, Common Anode LHDP | 780 μcd/seg | |
| | 5082-7631 | Green, Common Anode RHDP | | |
| | 5082-7633 | Green, Common Cathode RHDP | | |
| | 5082-7636 | 7.11mm (.29") Green, Universal Polarity and Overflow Indicator RHDP | | |
|  10.92mm (.43")<br>Dual-In-Line<br>.75"H x .5"W x .25"D<br>(14 Pin Epoxy) | 5082-7650 | High Efficiency Red, Common Anode, LHDP | 3.0 mcd/seg | |
| | 5082-7651 | High Efficiency Red, Common Anode, RHDP | | |
| | 5082-7653 | High Efficiency Red, Common Cathode RHDP | | |
| | 5082-7656 | 10.36 (.4") High Efficiency Red Universal Polarity and Overflow Indicator RHDP | | |
| | 5082-7660 | Yellow Common Anode LHDP | 2.3 mcd/seg | |
| | 5082-7661 | Yellow Common Anode RHDP | | |
| | 5082-7663 | Yellow Common Cathode RHDP | | |
| | 5082-7666 | 10.36 (.4") Yellow Universal Polarity and Overflow Indicator RHDP | | |
| | 5082-7670 | Green Common Anode LHDP | 780 μcd/seg | |
| | 5082-7671 | Green Common Anode RHDP | | |
| | 5082-7673 | Green Common Cathode RHDP | | |
| | 5082-7676 | 10.36 (.4") Green Universal Polarity and Overflow Indicator RHDP | | |

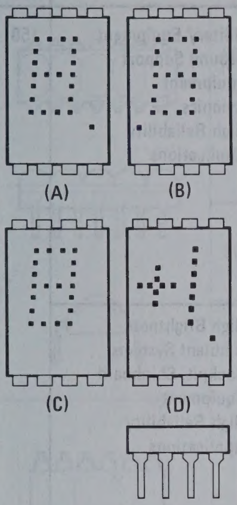
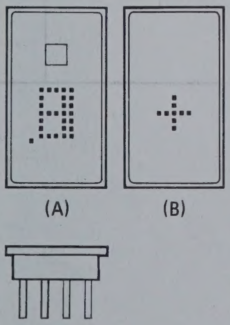
# Red, High Efficiency Red, Yellow and Green Seven Segment LED Displays (Cont.)

| Package | Device | Description | Typical $I_V$ @ 20 mA | Page No. |
|---|---|---|---|---|
| <br>7.62mm (.3")<br>Dual-In-Line<br>.75"H x .4"W x .18"D | 5082-7730 | Red, Common Anode, LHDP | 700 µcd/seg | 121 |
| | 5082-7731 | Red, Common Anode, RHDP | | |
| | 5082-7736 | 7.11mm (.29") Red, Common Anode, Polarity and Overflow Indicator | | |
| | 5082-7740 | Red, Common Cathode, RHDP | | |
| <br>10.92mm (.43")<br>Dual-In-Line<br>.75"H x .5"W x .25"D<br>(14 Pin Epoxy) | 5082-7750 | Red, Common Anode, LHDP | | |
| | 5082-7751 | Red, Common Anode, RHDP | | |
| | 5082-7756 | 10.36mm (.4") Red, Universal Polarity and Overflow Indicator, RHDP | | |
| | 5082-7760 | Red, Common Cathode, RHDP | | |
| <br>14.2mm (.56")<br>Dual-In-Line<br>.67"H x .49"W x .31"D | HDSP-5301 | Red, Common Anode RHDP | 900 µcd/seg | 125 |
| | HDSP-5303 | Red, Common Cathode RHDP | | |
| | HDSP-5307 | Red ±1, Common Anode | | |
| | HDSP-5308 | Red ±1, Common Cathode | | |
| | HDSP-5501 | High Efficiency Red, Common Anode, RHDP | 4.6 mcd/seg | |
| | HDSP-5503 | High Efficiency Red, Common Cathode, RHDP | | |
| | HDSP-5507 | High Efficiency Red ±1, Common Anode | | |
| | HDSP-5508 | High Efficiency Red ±1, Common Cathode | | |
| | HDSP-5701 | Yellow, Common Anode, RHDP | 3.6 mcd/seg | |
| | HDSP-5703 | Yellow, Common Cathode, RHDP | | |
| | HDSP-5707 | Yellow ±1, Common Anode | | |
| | HDSP-5708 | Yellow ±1, Common Cathode | | |
| | HDSP-5801 | Green, Common Anode, RHDP | 600 µcd/seg | |
| | HDSP-5803 | Green, Common Cathode, RHDP | | |
| | HDSP-5807 | Green ±1, Common Anode | | |
| | HDSP-5808 | Green ±1, Common Cathode | | |
| <br>20.32mm (.8") Dual-In-Line<br>1.09"H x .78"W x .33"D<br>(18 Pin Epoxy) | HDSP-3400 | Red, Common Anode, LHDP | 900 µcd/seg | 131 |
| | HDSP-3401 | Red, Common Anode, RHDP | | |
| | HDSP-3403 | Red, Common Cathode, RHDP | | |
| | HDSP-3405 | Red, Common Cathode, LHDP | | |
| | HDSP-3406 | 18.87mm (.74") Red, Universal Polarity Overflow Indicator, RHDP | | |

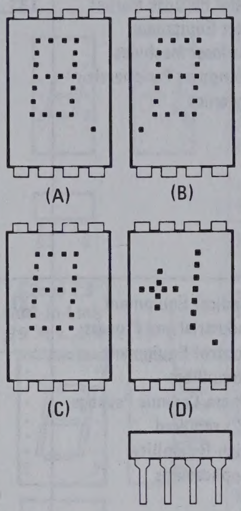
# High Light Ambient High Efficiency Red and Yellow Seven Segment Displays

| Package | Device | Description | Typical $I_V$ @ 100 mA Peak 1/5 Duty Factor | Page No. |
|---|---|---|---|---|
|  7.62mm (.3") Dual-In-Line .75"H x .4"W x .18"D | HDSP-3530 | High Efficiency Red, Common Anode, LHDP | 4.5 mcd/seg | 107 |
| | HDSP-3531 | High Efficiency Red, Common Anode, RHDP | | |
| | HDSP-3533 | High Efficiency Red, Common Cathode, RHDP | | |
| | HDSP-3536 | 7.11mm (.29") High Efficiency Red, Universal Polarity Overflow Indicator, RHDP | | |
| | HDSP-4030 | Yellow, Common Anode, LHDP | 4.5 mcd/seg | |
| | HDSP-4031 | Yellow, Common Anode, RHDP | | |
| | HDSP-4033 | Yellow, Common Cathode, RHDP | | |
| | HDSP-4036 | 7.11mm (.29") Yellow, Universal Polarity Overflow Indicator, RHDP | | |
|  10.92mm (.43")Dual-In-Line .75"H x .5"W x .25"D (14 Pin Epoxy) | HDSP-3730 | High Efficiency Red, Common Anode, LHDP | 5.0 mcd/seg | |
| | HDSP-3731 | High Efficiency Red, Common Anode, RHDP | | |
| | HDSP-3733 | High Efficiency Red, Common Cathode, RHDP | | |
| | HDSP-3736 | 10.36mm (.4") High Efficiency Red, Universal Polarity Overflow Indicator, RHDP | | |
| | HDSP-4130 | Yellow, Common Anode, LHDP | 5.0 mcd/seg | |
| | HDSP-4131 | Yellow, Common Anode, RHDP | | |
| | HDSP-4133 | Yellow, Common Cathode, RHDP | | |
| | HDSP-4136 | 10.36mm (.4") Yellow, Universal Polarity Overflow Indicator, RHDP | | |
|  14.2mm (.56") Dual-In-Line .67"H x .49"W x .31"D | HDSP-5531 | High Efficiency Red, Common Anode, RHDP | 7.0 mcd/seg | |
| | HDSP-5533 | High Efficiency Red, Common Cathode, RHDP | | |
| | HDSP-5537 | High Efficiency Red ±1, Common Anode | | |
| | HDSP-5538 | High Efficiency Red ±1, Common Cathode | | |
| | HDSP-5731 | Yellow, Common Anode, RHDP | 7.0 mcd/seg | |
| | HDSP-5733 | Yellow, Common Cathode, RHDP | | |
| | HDSP-5737 | Yellow ±1, Common Anode | | |
| | HDSP-5738 | Yellow ±1, Common Cathode | | |
|  20.32mm (.8") Dual-In-Line 1.09"H x .78"W x .33"D (18 Pin Epoxy) | HDSP-3900 | High Efficiency Red, Common Anode, LHDP | 7.0 mcd/seg | |
| | HDSP-3901 | High Efficiency Red, Common Anode, RHDP | | |
| | HDSP-3903 | High Efficiency Red, Common Cathode, RHDP | | |
| | HDSP-3905 | High Efficiency Red, Common Cathode, LHDP | | |
| | HDSP-3906 | 18.87mm (.74") High Efficiency Red, Universal Polarity Overflow Indicator, RHDP | | |
| | HDSP-4200 | Yellow, Common Anode, LHDP | 7.0 mcd/seg | |
| | HDSP-4201 | Yellow, Common Anode, RHDP | | |
| | HDSP-4203 | Yellow, Common Cathode, RHDP | | |
| | HDSP-4205 | Yellow, Common Cathode, LHDP | | |
| | HDSP-4206 | 18.87mm (.74") Yellow, Universal Polarity Overflow Indicator, RHDP | | |

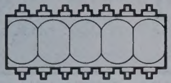
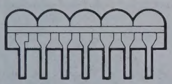
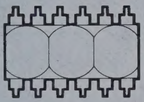
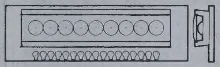
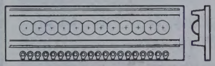
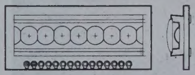
# Standard Red Numeric and Hexadecimal Dot Matrix Display

| Device | | Description | Package | Application | Page No. |
|---|---|---|---|---|---|
|  7.4mm (.29")<br>4x7 Single Digit | 5082-7300<br>(A) | Numeric RHDP<br>Built-in Decoder/Driver/Memory | 8 Pin Epoxy<br>15.2mm (.6") DIP | General Purpose Market<br>• Test Equipment<br>• Business Machines<br>• Computer Peripherals<br>• Avionics | 133 |
| | 5082-7302<br>(B) | Numeric LHDP<br>Built-in Decoder/Driver/Memory | | | |
| | 5082-7340<br>(C) | Hexadecimal<br>Built-in Decoder/Driver/Memory | | | |
| | 5082-7304<br>(D) | Character Plus/Minus Sign | | | |
| | 5082-7356<br>(A) | Numeric RHDP<br>Built-in Decoder/Driver/Memory | 8 Pin Glass Ceramic<br>15.2mm (.6") DIP | • Medical Equipment<br>• Industrial and Process Control Equipment<br>• Computers<br>• Where Ceramic Package IC's required<br>• High Reliability Applications | 137 |
| | 5082-7357<br>(B) | Numeric LHDP<br>Built-in Decoder/Driver/Memory | | | |
| | 5082-7359<br>(C) | Hexadecimal<br>Built-in Decoder/Driver/Memory | | | |
| | 5082-7358<br>(D) | Character Plus/Minus Sign | | | |
| | 4N51<br>(5082-7391)<br>4N51TXV<br>4N51TXVB<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | 8 Pin Hermetic<br>15.2mm (.6") DIP with gold plated leads | • Ground, Airborne, Shipboard Equipment<br>• Fire Control Systems<br>• Space Flight Systems<br>• Other High Reliability Applications | 142 |
| | 4N52<br>(5082-7392)<br>4N52TXV<br>4N52TXVB<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | | | |
| | 4N54<br>(5082-7395)<br>4N54TXV<br>4N54TXVB<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | | | |
| | 4N53<br>(5082-7393)<br>4N53TXV<br>4N53TXVB<br>(D) | Character Plus/Minus Sign<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | | | |
|  6.8mm (.27")<br>5x7 Single Digit | 5082-7010<br>(A) | Numeric LHDP<br>Built-in Decoder/Driver/Memory | 8 Pin Metal can<br>2.54mm (.100") Pin Centers | • Ground, Airborne, Shipboard Equipment<br>• Fire Control Systems<br>• Space Flight Systems | 154 |
| | 5082-7011<br>(B) | Plus/Minus Sign | | | |

# High Efficiency Red, Yellow and Green Numeric and Hexadecimal Displays

| Device and Package | | Description | Color | Application | Page No. |
|---|---|---|---|---|---|
|  <br>7.4 mm (.29")<br>4 x 7 Single Digit<br>Package:<br>8 Pin Glass Ceramic<br>15.2 mm (.6") DIP | HDSP-0760<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | High Efficiency Red<br>Low Power | • Military Equipment<br>• Ground Support Equipment<br>• Avionics<br>• High Reliability Applications | 150 |
| | HDSP-0761<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0762<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0763<br>(D) | Over Range ± 1 | | | |
| | HDSP-0770<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | High Efficiency Red<br>High Brightness | • High Brightness Ambient Systems<br>• Cockpit, Shipboard Equipment<br>• High Reliability Applications | |
| | HDSP-0771<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0772<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0763<br>(D) | Over Range ± 1 | | | |
| | HDSP-0860<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | Yellow | • Business Machines<br>• Fire Control Systems<br>• Military Equipment<br>• High Reliability Applications | |
| | HDSP-0861<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0862<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0863<br>(D) | Over Range ± 1 | | | |
| | HDSP-0960<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | Green | • Business Machines<br>• Fire Control Systems<br>• Military Equipment<br>• High Reliability Applications | |
| | HDSP-0961<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0962<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0963<br>(D) | Over Range ± 1 | | | |

# Red Seven Segment LED Displays

| Device | | Description | Package | Application | Page No. |
|---|---|---|---|---|---|
|  | 5082-7404 | 2.79mm(.11") Red, 4 Digits Centered D.P. | 12 Pin Epoxy, 7.62mm (.3") DIP | Small Display Market<br>• Portable/Battery Power Instruments<br>• Portable Calculators<br>• Digital Counters<br>• Digital Thermometers<br>• Digital Micrometers<br>• Stopwatches<br>• Cameras<br>• Copiers<br>• Digital Telephone Peripherals<br>• Data Entry Terminals<br>• Taxi Meters<br>For further information ask for Application Note 937. | 162 |
|  | 5082-7405 | 2.79mm(.11") Red, 5 Digits, Centered D.P. | 14 Pin Epoxy, 7.62mm (.3") DIP | | |
| | 5082-7414 | 2.79mm(.11") Red, 4 Digit, RHDP | 12 Pin Epoxy, 7.62mm (.3") DIP | | |
| | 5082-7415 | 2.79mm(.11") Red, 5 Digit, RHDP | 14 Pin Epoxy, 7.62mm (.3") DIP | | |
|  | 5082-7432 | 2.79mm(.11") Red, 2 Digits Right,[2] RHDP | 12 Pin Epoxy, 7.62mm (.3") DIP | | |
| | 5082-7433 | 2.79mm(.11") Red, 3 Digits, RHDP | | | |
|  | 5082-7441 | 2.67mm(.105") Red, 9 Digits, Mounted on P.C. Board | 50.8mm(2") PC Bd., 17 Term. Edge Con. | | 167 |
|  | 5082-7446 | 2.92mm(.115") Red, 16 Digits, Mounted on P.C. Board | 69.85mm(2.750")PC Bd., 24 Term. Edge Con. | | |
|  | 5082-7285 | 4.45mm(.175") Red, 5 Digits Mounted on P.C. Board. RHDP | 50.8mm(2") PC Bd., 15 Term. Edge Con. | | |
| | 5082-7295 | 4.45mm(.175") Red, 15 Digits, Mounted on P.C. Board. RHDP | 91.2mm(3.59") PC Bd., 23 Term. Edge Con. | | |

**HEWLETT PACKARD**

# FOUR CHARACTER 3.8 mm (0.15 INCH) 5x7 ALPHANUMERIC DISPLAYS

STANDARD RED HDSP-2000
YELLOW HDSP-2001
HIGH EFFICIENCY RED HDSP-2002

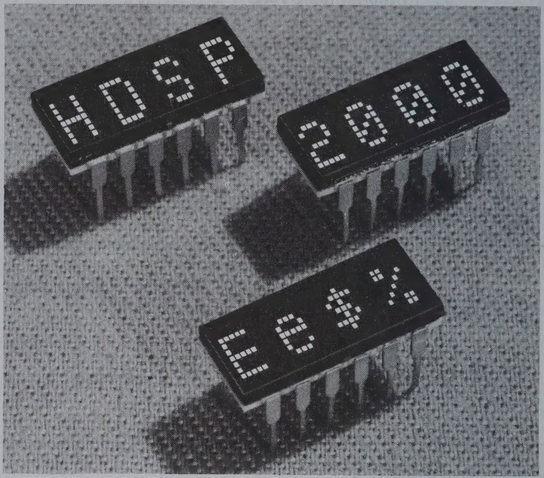
TECHNICAL DATA FEBRUARY 1982

## Features

- **THREE VERSIONS**

| | |
|---|---|
| **Standard Red** | **Low Power** |
| **Yellow** | **High Brightness** |
| **High Efficiency Red** | **High Brightness** |

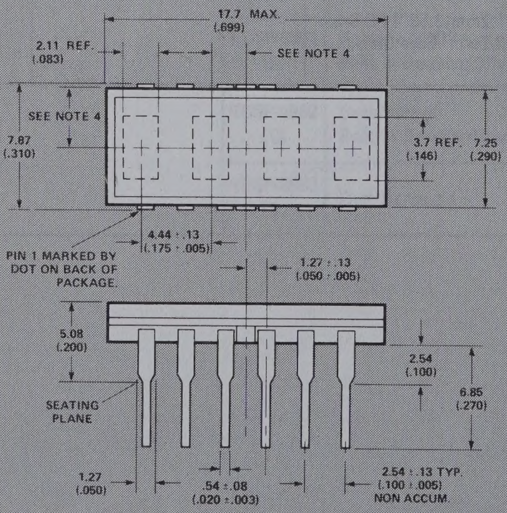
- **INTEGRATED SHIFT REGISTERS WITH CONSTANT CURRENT DRIVERS**
- **COMPACT CERAMIC PACKAGE**
- **WIDE VIEWING ANGLE**
- **END STACKABLE FOUR CHARACTER PACKAGE**
- **PIN ECONOMY**
  **12 Pins for Four Characters**
- **TTL COMPATIBLE**
- **5 x 7 LED MATRIX DISPLAYS FULL ASCII SET**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
- **HDSP-2001 ALSO CATEGORIZED FOR COLOR**



## Description

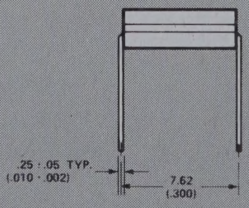
The HDSP-2000/-2001/-2002 series of displays are 3.8 mm (0.15 inch) 5 x 7 LED arrays for display of alphanumeric information. These devices are available in standard red, yellow, and high efficiency red. Each four character cluster is contained in a 12 pin dual-in-line package. An on-board SIPO (Serial-In-Parallel-Out) 7-bit shift register associated with each digit controls constant current LED row drivers. Full character display is achieved by external column strobing.

## Package Dimensions


17.7 MAX.
(.699)
2.11 REF.
(.083)
SEE NOTE 4
SEE NOTE 4
7.87
(.310)
3.7 REF.
(.146)
7.25
(.290)
4.44 ± .13
(.175 ± .005)
PIN 1 MARKED BY DOT ON BACK OF PACKAGE.
1.27 ± .13
(.050 ± .005)
5.08
(.200)
2.54
(.100)
6.85
(.270)
SEATING PLANE
1.27
(.050)
.54 ± .08
(.020 ± .003)
2.54 ± .13 TYP.
(.100 ± .005)
NON ACCUM.

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | COLUMN 1 | 7 | DATA OUT |
| 2 | COLUMN 2 | 8 | $V_B$ |
| 3 | COLUMN 3 | 9 | $V_{CC}$ |
| 4 | COLUMN 4 | 10 | CLOCK |
| 5 | COLUMN 5 | 11 | GROUND |
| 6 | INT. CONNECT* | 12 | DATA IN |

*DO NOT CONNECT OR USE


.25 ± .05 TYP.
(.010 ± .002)
7.62
(.300)

NOTES:
1. DIMENSIONS IN mm (inches).
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ± .38 mm (± .015")
3. LEAD MATERIAL IS COPPER ALLOY.
4. CHARACTERS ARE CENTERED WITH RESPECT TO LEADS WITHIN ± .13mm (± .005").

# Absolute Maximum Ratings (HDSP-2000/-2001/-2002)

Supply Voltage $V_{CC}$ to Ground .......... —0.5V to 6.0V
Inputs, Data Out and $V_B$ .................. —0.5V to $V_{CC}$
Column Input Voltage, $V_{COL}$ ............ —0.5V to +6.0V
Free Air Operating
Temperature Range, $T_A$[2] .......... —20° C to +85° C
Storage Temperature Range, $T_S$ ..... —55° C to +100° C
Maximum Allowable Package Dissipation
at $T_A$ = 25° C[1,2,3]
HDSP-2000/-2001/-2002 .................. 1.24 Watts
Maximum Solder Temperature 1.59 mm (0.63")
Below Seating Plane t < 5 secs ................ 260° C

# Recommended Operating Conditions (HDSP-2000/-2001/-2002)

| Parameter | Symbol | Min. | Nom. | Max. | Units |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.75 | 5.0 | 5.25 | V |
| Data Out Current, Low State | $I_{OL}$ | | | 1.6 | mA |
| Data Out Current, High State | $I_{OH}$ | | | -0.5 | mA |
| Column Input Voltage, Column On HDSP-2000 | $V_{COL}$ | 2.4 | | 3.5 | V |
| Column Input Voltage, Column On HDSP-2001/-2002 | $V_{COL}$ | 2.75 | | 3.5 | V |
| Setup Time | $t_{setup}$ | 70 | 45 | | ns |
| Hold Time | $t_{hold}$ | 30 | 0 | | ns |
| Width of Clock | $t_{w(Clock)}$ | 75 | | | ns |
| Clock Frequency | $f_{clock}$ | 0 | | 3 | MHz |
| Clock Transition Time | $t_{THL}$ | | | 200 | ns |
| Free Air Operating Temperature Range | $T_A$ | -20 | | 85 | °C |

# Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

**STANDARD RED HDSP-2000**

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK}$ = $V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1' | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | | $V_B$ = 2.4V | | 335 | 410 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25° C[6], $V_B$ = 2.4V | | 105 | 200 | | µcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC}$ = $V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | µA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | µA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | µA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | µA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.4V, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.58 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 655 | | nm |
| Dominant Wavelength[7] | | $\lambda_d$ | | | | 639 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 25 | | °C/W/ Device |

*All typical values specified at $V_{CC}$ = 5.0V and $T_A$ = 25° C unless otherwise noted.
**Power dissipation per package with four characters illuminated.

**Notes:**

1. Operation above 85° C ambient is possible provided the following conditions are met. The junction temperature should not exceed 125° C $T_J$ and the case temperature (as measured at pin 1 or the back of the display) should not exceed 100° C $T_C$.
2. The device should be derated linearly above 50° C at 16.7 mW/° C. This derating is based on a device mounted in a socket having a thermal resistance from case to ambient at 35° C/W per device. See Figure 2 for power deratings based on a lower thermal resistance.
3. Maximum allowable dissipation is derived from $V_{CC}$ = $V_B$ = 5.25V, $V_{COL}$ = 3.5V 20 LEDs on per character, 20% DF.

## YELLOW HDSP-2001

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK} = V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | All SR Stages = Logical 1 | $V_B$ = 2.4V | | 335 | 410 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25°C[6], $V_B$ = 2.4V | | 400 | 750 | | µcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC} = V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | µA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | µA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | µA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | µA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.75V, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.63 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 583 | | nm |
| Dominant Wavelength[5,7] | | $\lambda_d$ | | | | 585 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 25 | | °C/W/ Device |

## HIGH EFFICIENCY RED HDSP-2002

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK} = V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | All SR Stages = Logical 1 | $V_B$ = 2.4V | | 335 | 410 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25°C[6], $V_B$ = 2.4V | | 400 | 1430 | | µcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC} = V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | µA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | µA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | µA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | µA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.75V, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.63 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 635 | | nm |
| Dominant Wavelength[7] | | $\lambda_d$ | | | | 626 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 25 | | °C/W/ Device |

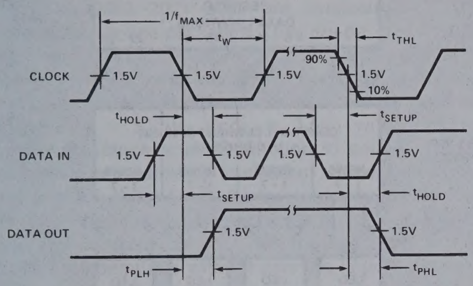
*All typical values specified at $V_{CC}$ = 5.0V and $T_A$ = 25°C unless otherwise noted.

**Power dissipation per package with four characters illuminated.

**Notes:**

4. The characters are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
5. The HDSP-2001 is categorized for color with the color category designated by a number code on the bottom of the package.
6. $T_i$ refers to the initial case temperature of the device immediately prior to the light measurement.
7. Dominant wavelength $\lambda_d$, is derived from the CIE chromaticity diagram, and represents the single wavelength which defines the color of the device.
8. The luminous sterance of the LED may be calculated using the following relationships:

$L_v$ (Lux) = $I_v$ (Candela)/A (Metre)$^2$
$L_v$ (Footlamberts) = $\pi I_v$ (Candela)/A (Foot)$^2$
A = $5.3 \times 10^{-8}$ M$^2$ = $5.8 \times 10^{-7}$ (Foot)$^2$


1/f_MAX
t_W
t_THL
90%
CLOCK
1.5V
1.5V
1.5V
1.5V
10%
t_HOLD
t_SETUP
DATA IN
1.5V
1.5V
1.5V
1.5V
t_SETUP
t_HOLD
DATA OUT
1.5V
1.5V
t_PLH
t_PHL

| Parameter | Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $f_{clock}$<br>CLOCK Rate | | | | 3 | MHz |
| $t_{PLH}$, $t_{PHL}$<br>Propagation delay CLOCK to DATA OUT | $C_L$ = 15pF<br>$R_L$=2.4KΩ | | | 125 | ns |

**Figure 1. Switching Characteristics HDSP-2000/-2001/-2002 ($T_A$ = -20° C to +70° C)**

## HDSP-2000

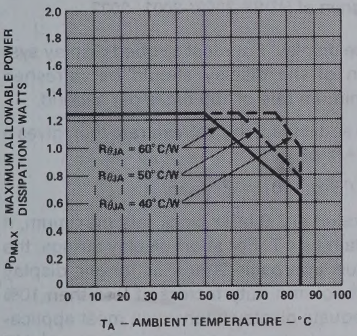


**Figure 2. Maximum Allowable Power Dissipation vs. Temperature**

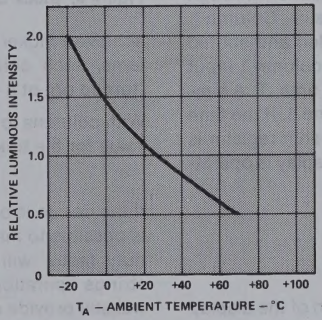


**Figure 3. Relative Luminous Intensity vs. Temperature**

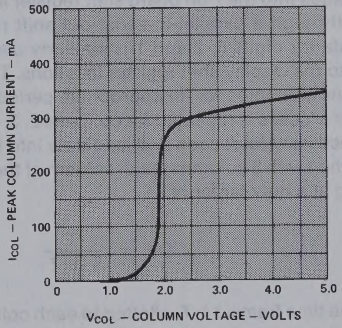


**Figure 4. Peak Column Current vs. Column Voltage**

## HDSP-2001/-2002

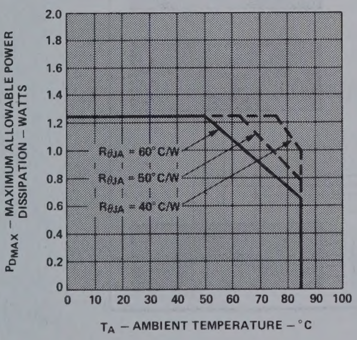


**Figure 5. Maximum Allowable Power Dissipation vs. Temperature**

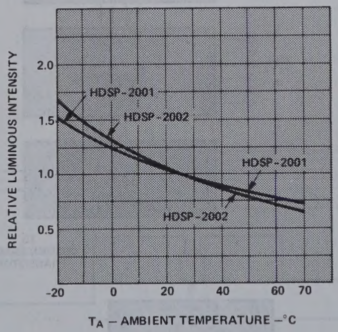


**Figure 6. Relative Luminous Intensity vs. Temperature**

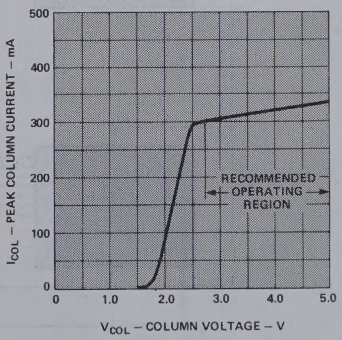


**Figure 7. Peak Column Current vs. Column Voltage**

# Electrical Description

The HDSP-200X series of four character alphanumeric displays have been designed to allow the user maximum flexibility in interface electronics design. Each four character display module features Data In and Data Out terminals arrayed for easy PC board interconnection such that display strings of up to 80 digits may be driven from a single character generator. Data Out represents the output of the 7th bit of digit number 4 shift register. Shift register clocking occurs on the high to low transition of the Clock input. The like columns of each character in a display cluster are tied to a single pin. Figure 8 is the block diagram for the displays. High true data in the shift register enables the output current mirror driver stage associated with each row of LEDs in the 5 x 7 diode array.

The TTL compatible $V_B$ input may either be tied to $V_{CC}$ for maximum display intensity or pulse width modulated to achieve intensity control and reduction in power consumption.

The normal mode of operation is depicted in the block diagram of Figure 9. In this circuit, binary input data for digit 4, column 1 is decoded by the 7 line output ROM and then loaded into the 7 on board shift register locations 1 through 7 through a parallel-in-serial-out shift register. Column 1 data for digits 3, 2 and 1 is similarly decoded and shifted into the display shift register locations. The column 1 input is now enabled for an appropriate period of time, T. A similar process is repeated for columns 2, 3, 4 and 5. If the time necessary to decode and load data into the shift register is t, then with 5 columns, each column of the display is operating at a duty factor of:

$$\text{D.F.} = \frac{T}{5\,(t+T)}$$

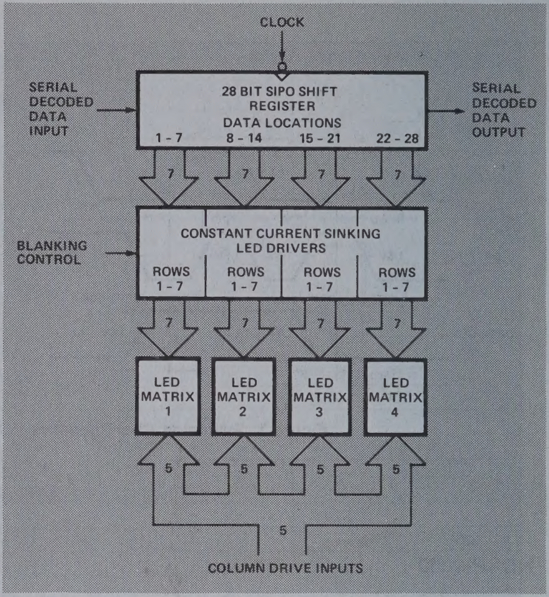

CLOCK
SERIAL DECODED DATA INPUT
28 BIT SIPO SHIFT REGISTER
DATA LOCATIONS
1 - 7
8 - 14
15 - 21
22 - 28
SERIAL DECODED DATA OUTPUT
7
7
7
7
BLANKING CONTROL
CONSTANT CURRENT SINKING LED DRIVERS
ROWS 1 - 7
ROWS 1 - 7
ROWS 1 - 7
ROWS 1 - 7
7
7
7
7
LED MATRIX 1
LED MATRIX 2
LED MATRIX 3
LED MATRIX 4
5
5
5
5
5
COLUMN DRIVE INPUTS

**Figure 8. Block Diagram of HDSP-2000/-2001/-2002**

The time frame, t + T, allotted to each column of the display is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.

With columns to be addressed, this refresh rate then gives a value for the time t + T of:

$$1/[5 \times (100)] = 2 \text{ msec.}$$

If the device is operated at 3.0 MHz clock rate maximum, it is possible to maintain t << T. For short display strings, the duty factor will then approach 20%. For longer display strings operation at column duty factors of less than 10% will still provide adequate display intensity in most applications. For further applications information, refer to HP Application Notes 1001 and 966 and Application Bulletin 56.

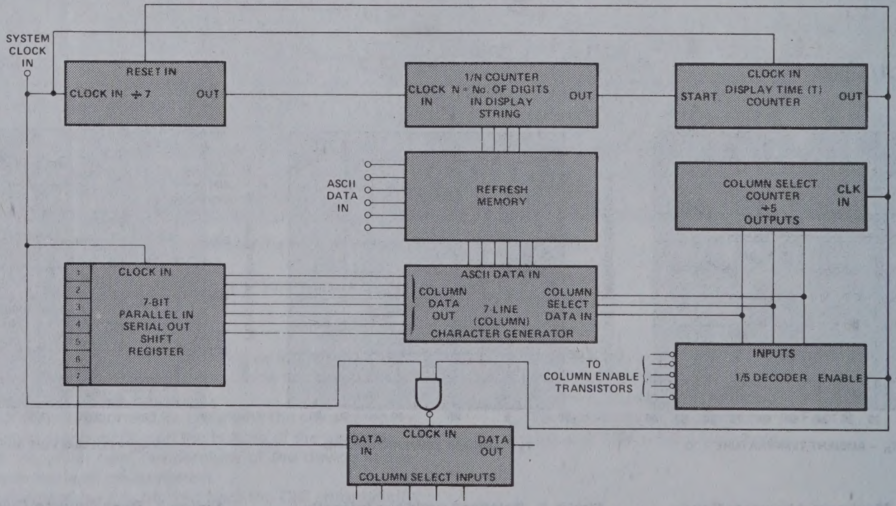

SYSTEM CLOCK IN
RESET IN
CLOCK IN ÷7
OUT
1/N COUNTER
CLOCK IN
N = No. OF DIGITS IN DISPLAY STRING
OUT
CLOCK IN
START
DISPLAY TIME (T) COUNTER
OUT
ASCII DATA IN
REFRESH MEMORY
COLUMN SELECT COUNTER ÷5
OUTPUTS
CLK IN
1
2
3
4
5
6
7
CLOCK IN
7-BIT PARALLEL IN SERIAL OUT SHIFT REGISTER
ASCII DATA IN
COLUMN DATA OUT
7 LINE (COLUMN) CHARACTER GENERATOR
COLUMN SELECT DATA IN
TO COLUMN ENABLE TRANSISTORS
INPUTS
1/5 DECODER
ENABLE
DATA IN
CLOCK IN
DATA OUT
COLUMN SELECT INPUTS

**Figure 9. Block Diagram of a Basic Display System**

# Mechanical and Thermal Considerations

The HDSP-2000/-2001/-2002 are available in standard ceramic dual-in-line packages. They are designed for plugging into sockets or soldering into PC boards. The packages may be horizontally or vertically stacked for character arrays of any desired size. Full power operation ($V_{CC} = V_B = 5.25V$, $V_{COL} = 3.5V$) with worst case thermal resistance from IC junction to ambient of 60°C/watt/device is possible up to ambient temperature of 50°C. For operation above 50°C, the maximum device dissipation should be derated linearly at 16.7 mW/°C (see Figure 5). With an improved thermal design, operation at higher ambient temperatures without derating is possible.

Power derating for this family of displays can be achieved in several ways. The power supply voltage can be lowered to a minimum of 4.75V. Column Input Voltage, $V_{COL}$, can be decreased to the recommended minimum values of 2.4V for the HDSP-2000 and 2.75V for the HDSP-2001/-2002. Also, the average drive current can be decreased through pulse width modulation of $V_B$.

The HDSP-2000/-2001/-2002 displays have integral glass lenses. A front panel contrast filter is desirable in most actual display applications. Some suggested filters for the HDSP-2000 are Panelgraphic Rudy Red 60, SGL Homalite H100-1605 and Plexiglass 2423. Filters for high ambient viewing of the HDSP-2001/-2002 include Panelgraphic Gray 10, SGL Homalite H100-1266 Gray, 3M Light Control Film (louvered filters), and Optical Coating Labs Sunguard.

Post solder cleaning may be accomplished using water, Freon/alcohol mixture for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents include Freon TF, Freon TE, Genesolv DI-15, and Genesolv DE-15.

**HEWLETT PACKARD**

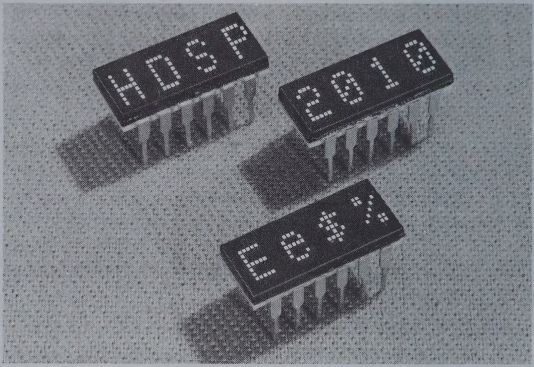
# FOUR CHARACTER RED ALPHANUMERIC DISPLAY FOR EXTENDED TEMPERATURE APPLICATIONS

# HDSP-2010 TXV-2010

TECHNICAL DATA FEBRUARY 1982

## Features

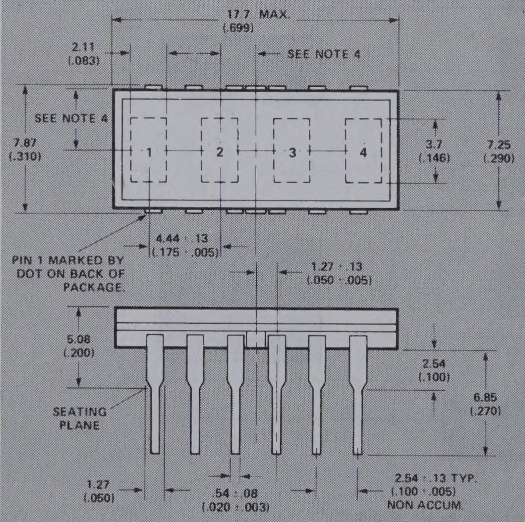
- OPERATION GUARANTEED TO $T_A$ = -40° C
- LEAK RATE GUARANTEED<br>TXV Screening Available
- 100% TEMPERATURE CYCLED<br>-55° C to +100° C
- GOLD PLATED LEADS
- INTEGRATED SHIFT REGISTERS WITH CONSTANT CURRENT DRIVERS
- CERAMIC 7.62mm (.3 in.) DIP<br>Integral Red Glass Contrast Filter
- WIDE VIEWING ANGLE
- END STACKABLE 4 CHARACTER PACKAGE
- PIN ECONOMY<br>12 Pins for 4 Characters
- TTL COMPATIBLE
- 5 x 7 LED MATRIX DISPLAYS FULL ASCII CODE
- RUGGED, LONG OPERATING LIFE
- CATEGORIZED FOR LUMINOUS INTENSITY<br>Assures Ease of Package to Package Brightness Matching


HDSP
2010
E8$%

## Description

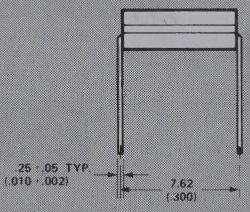
The HP HDSP-2010 display is designed for use in applications requiring high reliability. The character font is a 3.8mm (0.15 inch) 5 x 7 red LED array for displaying alphanumeric information. The device is available in 4 character clusters and is packaged in a 12-pin dual-in-line type package. An on-board SIPO (serial-in-parallel-out) 7-bit shift register associated with each digit controls constant current LED row drivers. Full character display is achieved by external column strobing. The constant current LED drivers are externally programmable and typically capable of sinking 13.5mA peak per diode. Applications include interactive I/O terminals, avionics, portable telecommunications gear, and hand held equipment requiring alphanumeric displays.

## Package Dimensions


17.7 MAX.
(.699)
2.11
(.083)
SEE NOTE 4
SEE NOTE 4
7.87
(.310)
1
2
3
4
3.7
(.146)
7.25
(.290)
4.44 ± .13
(.175 ± .005)
PIN 1 MARKED BY DOT ON BACK OF PACKAGE.
1.27 ± .13
(.050 ± .005)
5.08
(.200)
SEATING PLANE
2.54
(.100)
6.85
(.270)
1.27
(.050)
.54 ± .08
(.020 ± .003)
2.54 ± .13 TYP.
(.100 ± .005)
NON ACCUM.

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | COLUMN 1 | 7 | DATA OUT |
| 2 | COLUMN 2 | 8 | $V_B$ |
| 3 | COLUMN 3 | 9 | $V_{CC}$ |
| 4 | COLUMN 4 | 10 | CLOCK |
| 5 | COLUMN 5 | 11 | GROUND |
| 6 | INT. CONNECT* | 12 | DATA IN |

*DO NOT CONNECT OR USE


.25 ± .05 TYP.
(.010 ± .002)
7.62
(.300)

NOTES:
1. DIMENSIONS IN mm (inches).
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ±.38 mm (±.015")
3. LEAD MATERIAL IS GOLD PLATED COPPER ALLOY.
4. CHARACTERS ARE CENTERED WITH RESPECT TO LEADS WITHIN ±.13mm (±.005").

## Absolute Maximum Ratings

Supply Voltage $V_{CC}$ to Ground .......... −0.5V to 6.0V
Inputs, Data Out and $V_B$ ................ −0.5V to $V_{CC}$
Column Input Voltage, $V_{COL}$ .......... −0.5V to +6.0V
Free Air Operating Temperature
Range, $T_A$[2]........................ −40°C to +85°C
Storage Temperature Range, $T_S$ ..... -55°C to +100°C
Maximum Allowable Package Dissipation
at $T_A = 25°C$[1,2,6] ........................ 1.29 Watts
Maximum Solder Temperature 1.59mm (.063")
Below Seating Plane t<5 secs ............... 260°C

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Nom. | Max. | Units |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.75 | 5.0 | 5.25 | V |
| Data Out Current, Low State | $I_{OL}$ | | | 1.6 | mA |
| Data Out Current, HighState | $I_{OH}$ | | | −0.5 | mA |
| Column Input Voltage, Column On | $V_{COL}$ | 2.6 | | 3.5 | V |
| Setup Time | $t_{setup}$ | 70 | 45 | | ns |
| Hold Time | $t_{hold}$ | 30 | 0 | | ns |
| Width of Clock | $t_{w(Clock)}$ | 75 | | | ns |
| Clock Frequency | $f_{clock}$ | 0 | | 3 | MHz |
| Clock Transition Time | $t_{THL}$ | | | 200 | ns |
| Free Air Operating Temperature Range | $T_A$ | -40 | | 85 | °C |

## Electrical Characteristics Over Operating Temperature Range

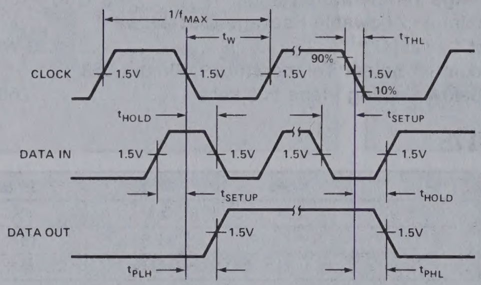
(Unless otherwise specified.)

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC} = 5.25V$<br>$V_{CLOCK} = V_{DATA} = 2.4V$<br>All SR Stages = Logical 1 | $V_B = 0.4V$ | | 45 | 60 | mA |
| | | | | $V_B = 2.4V$ | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC} = 5.25V$<br>$V_{COL} = 3.5V$<br>All SR Stages = Logical 1 | $V_B = 0.4V$ | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | | $V_B = 2.4V$ | | 350 | 435 | mA |
| Peak Luminous Intensity per LED[3,7] (Character Average) | | $I_{VPEAK}$ | $V_{CC} = 5.0V$, $V_{COL} = 3.5V$<br>$T_i = 25°C$[4] $V_B = 2.4V$ | | 105 | 200 | | μcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC} = V_{COL} = 4.75V$ | | 2.0 | | | V |
| $V_B$, Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Clock Threshold Low | | $V_{IL}$ | | | | | 0.6 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC} = 5.25V$, $V_{IH} = 2.4V$ | | | 20 | 80 | μA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | μA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC} = 5.25V$, $V_{IL} = 0.4V$ | | | -500 | -800 | μA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | μA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC} = 4.75V$, $I_{OH} = -0.5mA$, $V_{COL} = 0V$ | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC} = 4.75V$, $I_{OL} = 1.6mA$, $V_{COL} = 0V$ | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC} = 5.0V$, $V_{COL} = 2.6V$,<br>15 LEDs on per character, $V_B = 2.4V$ | | | 0.66 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 655 | | nm |
| Dominant Wavelength[5] | | $\lambda_d$ | | | | 640 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 25 | | °C/W/Device |
| Leak Rate | | | | | | | $5 \times 10^{-7}$ | cc/s |

*All typical values specified at $V_{CC} = 5.0V$ and $T_A = 25°C$ unless otherwise noted.

**Power dissipation per package with 4 characters illuminated.

1. Operation above 85°C ambient is possible provided the following conditions are met. The junction temperature should not exceed 125°C $T_J$ and the case temperature as measured at pin 1 or the back of the display should not exceed 100°C $T_C$.
2. The device should be derated linearly above 50°C at 16.7 mW/°C. This derating is based on a device mounted in a socket having a thermal resistance from case to ambient at 35° C/W per device. See Figure 2 for power deratings based on a lower thermal resistances.
3. The characters are categorized for Luminous Intensity with the category designated by a letter code on the bottom of the package.
4. $T_i$ refers to the initial case temperature of the device immediately prior to the light measurement.
5. Dominant wavelength $\lambda_d$, is derived from the CIE chromaticity diagram, and represents the single wavelength which defines the color of the device.
6. Maximum allowable dissipation is derived from $V_{CC} = V_B = 5.25$ Volts, $V_{COL} = 3.5V$, 20 LEDs on per character, 20% DF.
7. The luminous stearance of the LED may be calculated using the following relationships:
$L_v$ (Lux) = $I_v$ (Candela)/A (Metre)$^2$
$L_v$ (Footlamberts) = $\pi I_v$ (Candela)/A (Foot)$^2$
A = $5.3 \times 10^{-8}$ M$^2$ = $5.8 \times 10^{-7}$ (Foot)$^2$



| Parameter | Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $f_{clock}$<br>CLOCK Rate | | | | 3 | MHz |
| $t_{PLH}$, $t_{PHL}$<br>Propagation delay CLOCK to DATA OUT | $C_L$ = 15pF<br>$R_L$=2.4KΩ | | | 125 | ns |

**Figure 1. Switching Characteristics. ($V_{CC}$ = 5V, $T_A$ = -40°C to +70°C)**

## Mechanical and Thermal Considerations

The HDSP-2010 is available in a standard 12 lead ceramic-glass dual in-line package. It is designed for plugging into DIP sockets or soldering into PC boards. The packages may be horizontally or vertically stacked for character arrays of any desired size.

The HDSP-2010 can be operated over a wide range of temperature and supply voltages. Power reduction can be achieved by either decreasing $V_{COL}$ or decreasing the average drive current through pulse width modulation of $V_B$.

The HDSP-2010 display has a glass lens. A front panel contrast filter is desirable in most actual display applications. Some suggested filters are Panel graphic Ruby Red 60, SGL Homalite H100-1605 Red and 3M Light Control Film (louvered filters). OCLI Sungard optically coated glass filters offer superior contrast enhancement.

Post solder cleaning may be accomplished using water, Freon/alcohol mixtures formulated for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents: Freon TF, Freon TE, Genesolv DI-15, Genesolv DE-15.

## Electrical Description

The HDSP-2010 display provides on-board storage of decoded column data and constant current sinking row drivers for each of 28 rows in the 4 character display. The device consists of four LED matrices and two integrated circuits that form a 28-bit serial input-parallel output (SIPO) shift register, see Figure 5. Each character is a 5 x 7 diode array arranged with the cathodes of each row connected to one constant current sinking output of the SIPO shift register. The anodes of each column are connected together, with the same column of each of the 4 characters connected together (i.e. column 1 of all four characters are connected to pin 1). Any LED within any character may be addressed by shifting data to the appropriate shift register location and applying a voltage to the appropriate column.

Associated with each shift register location is a constant current sinking LED driver, capable of sinking a nominal 13.5 mA. A logical 1 loaded into a shift register location enables the current source at that location. A voltage applied to the appropriate column input turns on the desired LED.

The display is column strobed on a 1 of 5 basis by loading 7 bits of row data per character for a selected column. The data is shifted through the SIPO shift register, one bit location for each high-to-low transition of the clock. When the HDSP-2010 display is operated with pin 1 in the lower left hand corner, the first bit that is loaded into the SIPO shift register will be the information for row 7 of the right most character. The 28th bit loaded into the SIPO shift register will be the information for row 1 of the left most character. When the 28 bits of row data for column 1 have been loaded into the SIPO shift register, the first column is energized for a time period, T, illuminating column 1 in all four characters. Column 1 is turned off and the process is repeated for columns 2 through 5.

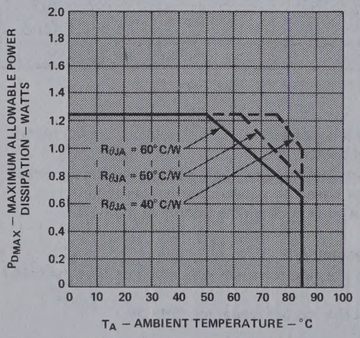


**Figure 2. Maximum Allowable Power Dissipation vs. Temperature.**

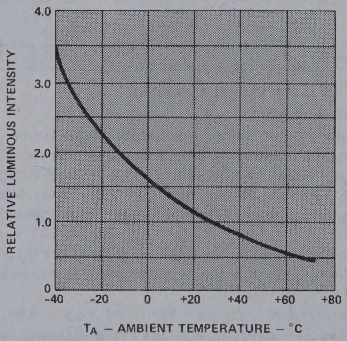


**Figure 3. Relative Luminous Intensity vs. Temperature.**

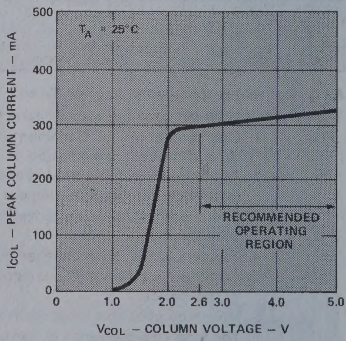


**Figure 4. Peak Column Current vs. Column Voltage.**

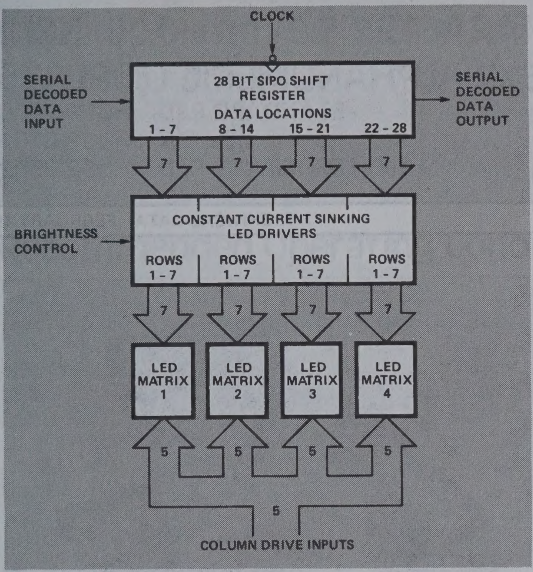

CLOCK
SERIAL DECODED DATA INPUT
28 BIT SIPO SHIFT REGISTER
DATA LOCATIONS
1 - 7
8 - 14
15 - 21
22 - 28
SERIAL DECODED DATA OUTPUT
7
BRIGHTNESS CONTROL
CONSTANT CURRENT SINKING LED DRIVERS
ROWS 1 - 7
LED MATRIX 1
LED MATRIX 2
LED MATRIX 3
LED MATRIX 4
5
COLUMN DRIVE INPUTS

**Figure 5. Block Diagram of the HDSP-2010 Display**

Knowing the time period, t, to load the data into the display, the LED on time duty factor, DF, may be determined

$$DF = \frac{T}{5(t+T)}$$

The time frame allotted per column is $(t + T)$ and the minimum recommended refresh rate for a flicker free display is 100 Hz, so that $(t + T) \leq 2$ ms. If the display is operated at the 3 MHz maximum clock rate, it is possible to maintain $t \ll T$. For display strings of 24 characters or less, the LED on time DF will be approximately 19.4%. For longer display strings, operation of the display with DF approximately 10% will provide adequate light output for indoor applications.

The 28th stage of the SIPO shift register is connected to the Data Output, which is designed to interface directly to the Data Input of the next HDSP-2010 in the display string.

The $V_B$ input may be used to control the apparent brightness of the display. A logic high applied to the $V_B$ input enables the display to be turned ON, and a logic low blanks the display by disabling the constant current LED drivers. Therefore, the time average luminous intensity of the display can be varied by pulse width modulation of $V_B$. For application and drive circuit information refer to HP Application Notes 966 and 1001.

## High Reliability Test Program

Hewlett-Packard provides standard high reliability test programs in order to facilitate the use of HP products in military programs. The TXV prefix identifies a part which has been preconditioned and screened per Table 1.

**PART NUMBER SYSTEM**

| Standard Product | With TXV Screening |
|---|---|
| HDSP-2010 | TXV-2010 |

**TABLE 1. TXV Preconditioning and Screening — 100%**

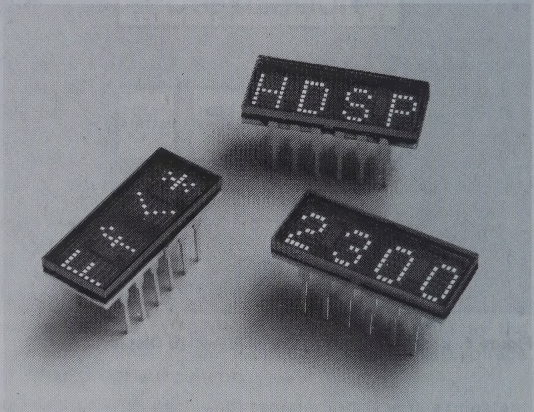
| Examination or Test | MIL-STD-883 Methods | Conditions |
|---|---|---|
| 1. Internal Visual Inspection | OED Procedure | |
| 2. High Temperature Storage | 1008 | 100° C, 24 Hrs. |
| 3. Temperature Cycling | 1010 | -55° C to +100° C, 10 Cycles |
| 4. Constant Acceleration | 2001 | 2,000 G's, $Y_1$ Orientation |
| 5. Fine Leak | 1014 | Condition A |
| 6. Gross Leak | 1014 | Condition C, Inspect at 100° C |
| 7. Electrical Test: ($I_v$, $I_{CC}$, $I_{COL}$, $I_{IL}$, $I_{IH}$, $V_{OH}$, $V_{OL}$) | | |
| 8. Burn-In | 1015 | $T_A = 70°$ C, t = 168 hrs. $P_D = .9$W Max |
| 9. Electrical Test: ($I_v$, $I_{CC}$, $I_{COL}$, $I_{IL}$, $I_{IH}$, $V_{OH}$, $V_{OL}$) | | |
| 10. External Visual | 2009 | |

**HEWLETT PACKARD**

# FOUR CHARACTER 5.0 mm (0.20 INCH) 5x7 ALPHANUMERIC DISPLAYS

STANDARD RED HDSP-2300
YELLOW HDSP-2301
HIGH EFFICIENCY RED HDSP-2302

TECHNICAL DATA FEBRUARY 1982



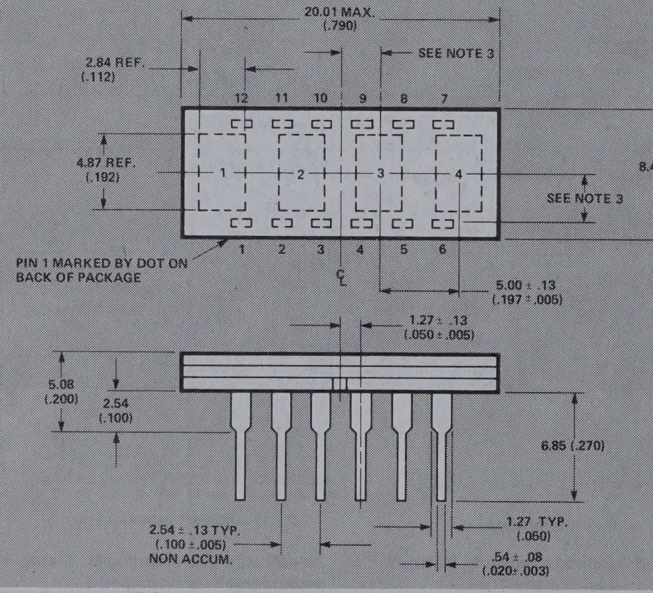
## Features

- **THREE VERSIONS**
  - **Standard Red Low Power**
  - **Yellow High Brightness**
  - **High Efficiency Red High Brightness**
- **INTEGRATED SHIFT REGISTERS WITH CONSTANT CURRENT DRIVERS**
- **COMPACT CERAMIC PACKAGE**
- **WIDE VIEWING ANGLE**
- **END STACKABLE FOUR CHARACTER PACKAGE**
- **PIN ECONOMY**
  **12 Pins for Four Characters**
- **TTL COMPATIBLE**
- **5 x 7 LED MATRIX DISPLAYS FULL ASCII SET**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
- **HDSP-2301 ALSO CATEGORIZED FOR COLOR**

## Description

The HDSP-2300/-2301/-2302 series of displays are 5.0 mm (0.20 inch) 5 x 7 LED arrays for display of alphanumeric information. These devices are available in standard red, yellow, and high efficiency red. Each four character cluster is contained in a 12 pin dual-in-line package. An on-board SIPO (Serial-In-Parallel-Out) 7-bit shift register associated with each digit controls constant current LED row drivers. Full character display is achieved by external column strobing.

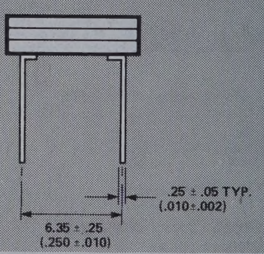
## Package Dimensions


20.01 MAX.
(.790)
2.84 REF.
(.112)
SEE NOTE 3
12
11
10
9
8
7
1
2
3
4
4.87 REF.
(.192)
8.43 MAX.
(.335)
SEE NOTE 3
1
2
3
4
5
6
PIN 1 MARKED BY DOT ON BACK OF PACKAGE
℄
5.00 ± .13
(.197 ± .005)
1.27 ± .13
(.050 ± .005)
5.08
(.200)
2.54
(.100)
6.85 (.270)
2.54 ± .13 TYP.
(.100 ± .005)
NON ACCUM.
1.27 TYP.
(.050)
.54 ± .08
(.020 ± .003)

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | COLUMN 1 | 7 | DATA OUT |
| 2 | COLUMN 2 | 8 | $V_B$ |
| 3 | COLUMN 3 | 9 | $V_{CC}$ |
| 4 | COLUMN 4 | 10 | CLOCK |
| 5 | COLUMN 5 | 11 | GROUND |
| 6 | INT. CONNECT* | 12 | DATA IN |

*DO NOT CONNECT OR USE

NOTES:
1. DIMENSIONS IN mm (inches).
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ±.38 mm (±.015").
3. CHARACTERS ARE CENTERED WITH RESPECT TO LEADS WITHIN ±.13mm (±.005").


.25 ± .05 TYP.
(.010 ± .002)
6.35 ± .25
(.250 ± .010)

# Absolute Maximum Ratings (HDSP-2300/-2301/2302)

Supply Voltage $V_{CC}$ to Ground .......... —0.5V to 6.0V
Inputs, Data Out and $V_B$ .................. —0.5V to $V_{CC}$
Column Input Voltage, $V_{COL}$ ............ —0.5V to +6.0V
Free Air Operating
Temperature Range, $T_A$[2] .......... —20° C to +85° C
Storage Temperature Range, $T_S$ ..... —55° C to +100° C

Maximum Allowable Package Dissipation
at $T_A$ = 25° C[1,2,3]
HDSP-2300 ................................ 1.24 Watts
HDSP-2301/-2302 ........................ 1.46 Watts
Maximum Solder Temperature 1.59 mm (0.63")
Below Seating Plane t < 5 secs ................ 260° C

# Recommended Operating Conditions (HDSP-2300/-2301/-2302)

| Parameter | Symbol | Min. | Nom. | Max. | Units |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.75 | 5.0 | 5.25 | V |
| Data Out Current, Low State | $I_{OL}$ | | | 1.6 | mA |
| Data Out Current, High State | $I_{OH}$ | | | -0.5 | mA |
| Column Input Voltage, Column On HDSP-2300 | $V_{COL}$ | 2.4 | | 3.5 | V |
| Column Input Voltage, Column On HDSP-2301/-2302 | $V_{COL}$ | 2.75 | | 3.5 | V |
| Setup Time | $t_{setup}$ | 70 | 45 | | ns |
| Hold Time | $t_{hold}$ | 30 | 0 | | ns |
| Width of Clock | $t_{w(Clock)}$ | 75 | | | ns |
| Clock Frequency | $f_{clock}$ | 0 | | 3 | MHz |
| Clock Transition Time | $t_{THL}$ | | | 200 | ns |
| Free Air Operating Temperature Range | $T_A$ | -20 | | 85 | °C |

# Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

**STANDARD RED HDSP-2300**

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK} = V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1' | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | | $V_B$ = 2.4V | | 335 | 410 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25° C[6], $V_B$ = 2.4V | | 105 | 200 | | μcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC} = V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | μA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | μA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | μA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | μA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.4V, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.58 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 655 | | nm |
| Dominant Wavelength[7] | | $\lambda_d$ | | | | 639 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 25 | | °C/W/ Device |

*All typical values specified at $V_{CC}$ = 5.0V and $T_A$ = 25° C unless otherwise noted.
**Power dissipation per package with four characters illuminated.

**Notes:**

1. Operation above 85° C ambient is possible provided the following conditions are met. The junction temperature should not exceed 125° C $T_J$ and the case temperature (as measureed at pin 1 or the back of the display) should not exceed 100° C $T_C$.
2. The HDSP-2300 should be derated linearly above 50° C at 16.7 mW/° C. The HDSP-2301/-2302 should be derated linearly above 37° C at 16.7 mW/° C. This derating is based on a device mounted in a socket having a thermal resistance from case to ambient at 35° **C/W per device. See Figure 2 for power deratings based on a lower thermal resistance.
3. Maximum allowable dissipation is derived from $V_{CC} = V_B$ = 5.25V, $V_{COL}$ = 3.5V 20 LEDs on per character, 20% DF.

## YELLOW HDSP-2301

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK}$ = $V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | All SR Stages = Logical 1 | $V_B$ = 2.4V | | 380 | 520 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25°C[6], $V_B$ = 2.4V | | 650 | 1140 | | μcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC}$ = $V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | μA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | μA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | 500 | -800 | μA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | μA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.75V, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.67 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 583 | | nm |
| Dominant Wavelength[5,7] | | $\lambda_d$ | | | | 585 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 25 | | °C/W/ Device |

## HIGH EFFICIENCY RED HDSP-2302

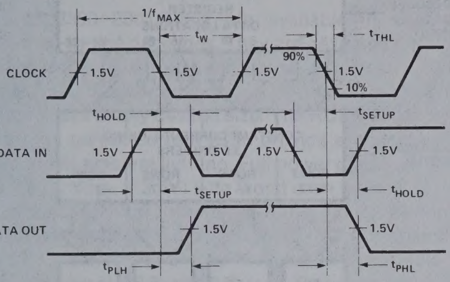
| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK}$ = $V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | All SR Stages = Logical 1 | $V_B$ = 2.4V | | 380 | 520 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25°C[6], $V_B$ = 2.4V | | 650 | 1430 | | μcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC}$ = $V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | μA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | μA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | μA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | μA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.75V, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.67 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 635 | | nm |
| Dominant Wavelength[7] | | $\lambda_d$ | | | | 626 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 25 | | °C/W/ Device |

*All typical values specified at $V_{CC}$ = 5.0V and $T_A$ = 25°C unless otherwise noted.
**Power dissipation per package with four characters illuminated.

**Notes:**

4. The characters are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
5. The HDSP-2301 is categorized for color with the color category designated by a number code on the bottom of the package.
6. $T_i$ refers to the initial case temperature of the device immediately prior to the light measurement.
7. Dominant wavelength $\lambda_d$, is derived from the CIE chromaticity diagram, and represents the single wavelength which defines the color of the device.
8. The luminous sterance of the LED may be calculated using the following relationships:

   $L_v$ (Lux) = $I_v$ (Candela)/A (Metre)$^2$
   $L_v$ (Footlamberts) = $\pi I_v$ (Candela)/A (Foot)$^2$
   A = $5.3 \times 10^{-8}$ M$^2$ = $5.8 \times 10^{-7}$ (Foot)$^2$


1/f_MAX
t_W
t_THL
90%
10%
CLOCK
1.5V
1.5V
1.5V
1.5V
t_HOLD
t_SETUP
DATA IN
1.5V
1.5V
1.5V
1.5V
t_SETUP
t_HOLD
DATA OUT
1.5V
1.5V
t_PLH
t_PHL

| Parameter | Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $f_{clock}$ CLOCK Rate | | | | 3 | MHz |
| $t_{PLH}$, $t_{PHL}$ Propagation delay CLOCK to DATA OUT | $C_L$ = 15pF<br>$R_L$=2.4KΩ | | | 125 | ns |

**Figure 1. Switching Characteristics HDSP-2300/-2301/-2302 ($T_A$ = -20° C to +70° C)**

## HDSP-2300

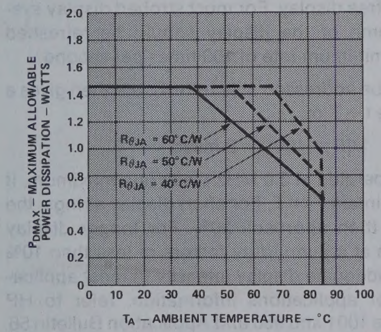


**Figure 2. Maximum Allowable Power Dissipation vs. Temperature**

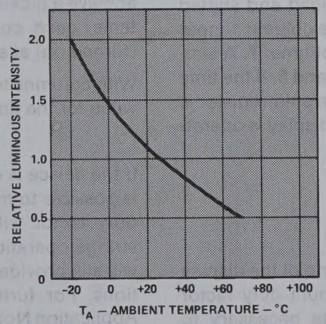


**Figure 3. Relative Luminous Intensity vs. Temperature**

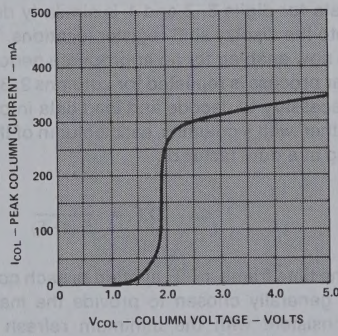


**Figure 4. Peak Column Current vs. Column Voltage**

## HDSP-2301/2302

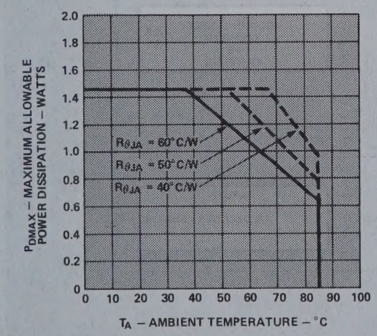


**Figure 5. Maximum Allowable Power Dissipation vs. Temperature**

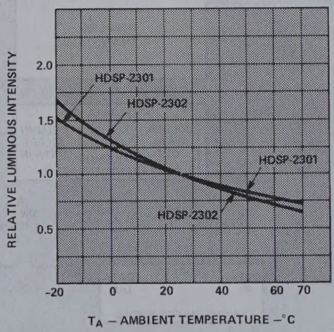


**Figure 6. Relative Luminous Intensity vs. Temperature**

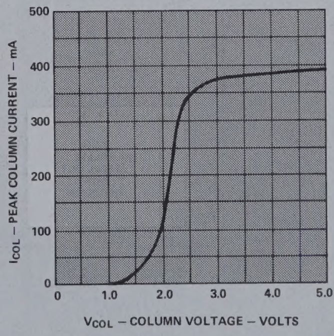


**Figure 7. Peak Column Current vs. Column Voltage**

# Electrical Description

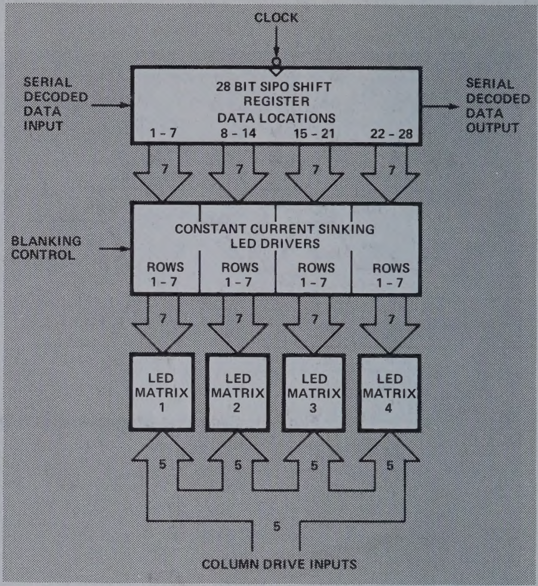
The HDSP-230X series of four character alphanumeric displays have been designed to allow the user maximum flexibility in interface electronics design. Each four character display module features Data In and Data Out terminals arrayed for easy PC board interconnection such that display strings of up to 80 digits may be driven from a single character generator. Data Out represents the output of the 7th bit of digit number 4 shift register. Shift register clocking occurs on the high to low transition of the Clock input. The like columns of each character in a display cluster are tied to a single pin. Figure 8 is the block diagram for the displays. High true data in the shift register enables the output current mirror driver stage associated with each row of LEDs in the 5 x 7 diode array.

The TTL compatible $V_B$ input may either be tied to $V_{CC}$ for maximum display intensity or pulse width modulated to achieve intensity control and reduction in power consumption.

The normal mode of operation is depicted in the block diagram of Figure 9. In this circuit, binary input data for digit 4, column 1 is decoded by the 7 line output ROM and then loaded into the 7 on board shift register locations 1 through 7 through a parallel-in-serial-out shift register. Column 1 data for digits 3, 2 and 1 is similarly decoded and shifted into the display shift register locations. The column 1 input is now enabled for an appropriate period of time, T. A similar process is repeated for columns 2, 3, 4 and 5. If the time necessary to decode and load data into the shift register is t, then with 5 columns, each column of the display is operating at a duty factor of:

$$\text{D.F.} = \frac{T}{5\,(t+T)}$$

The time frame, $t + T$, allotted to each column of the display is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.



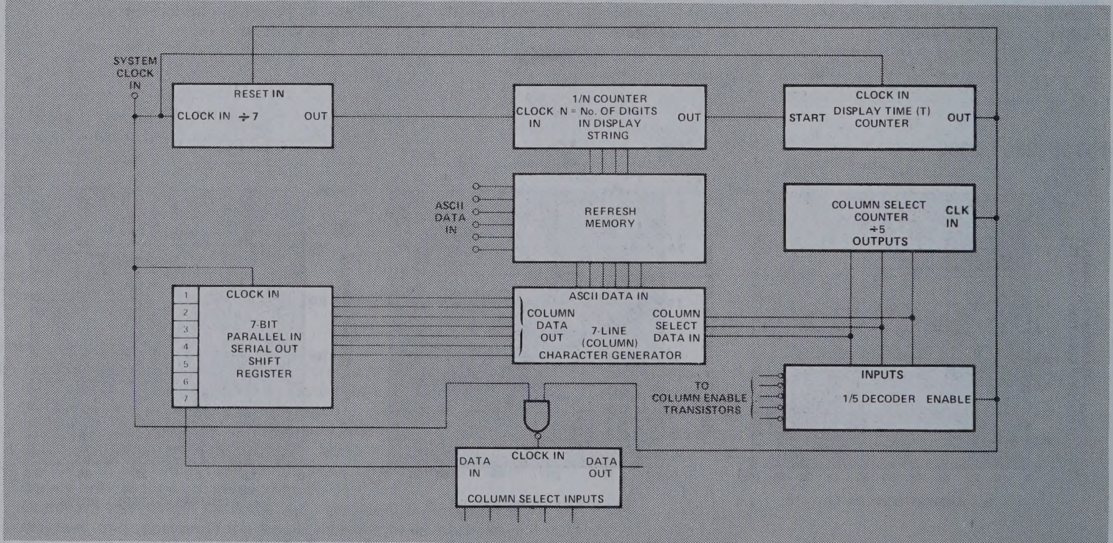
CLOCK
SERIAL DECODED DATA INPUT
28 BIT SIPO SHIFT REGISTER
DATA LOCATIONS
1 - 7
8 - 14
15 - 21
22 - 28
SERIAL DECODED DATA OUTPUT
7
7
7
7
BLANKING CONTROL
CONSTANT CURRENT SINKING LED DRIVERS
ROWS 1 - 7
ROWS 1 - 7
ROWS 1 - 7
ROWS 1 - 7
7
7
7
7
LED MATRIX 1
LED MATRIX 2
LED MATRIX 3
LED MATRIX 4
5
5
5
5
5
COLUMN DRIVE INPUTS

**Figure 8. Block Diagram of HDSP-2300/-2301/-2302**

With columns to be addressed, this refresh rate then gives a value for the time $t + T$ of:

$$1/[5 \times (100)] = 2 \text{ msec.}$$

If the device is operated at 3.0 MHz clock rate maximum, it is possible to maintain $t << T$. For short display strings, the duty factor will then approach 20%. For longer display strings operation at column duty factors of less than 10% will still provide adequate display intensity in most applications. For further applications information, refer to HP Application Notes 1001 and 966 and Application Bulletin 56.



SYSTEM CLOCK IN
RESET IN
CLOCK IN ÷7
OUT
1/N COUNTER
CLOCK IN
N = No. OF DIGITS IN DISPLAY STRING
OUT
CLOCK IN
START
DISPLAY TIME (T) COUNTER
OUT
ASCII DATA IN
REFRESH MEMORY
COLUMN SELECT COUNTER ÷5 OUTPUTS
CLK IN
1
2
3
4
5
6
7
CLOCK IN
7-BIT PARALLEL IN SERIAL OUT SHIFT REGISTER
ASCII DATA IN
COLUMN DATA OUT
7-LINE (COLUMN) CHARACTER GENERATOR
COLUMN SELECT DATA IN
INPUTS
1/5 DECODER
ENABLE
TO COLUMN ENABLE TRANSISTORS
DATA IN
CLOCK IN
DATA OUT
COLUMN SELECT INPUTS

**Figure 9. Block Diagram of a Basic Display System**

# Mechanical and Thermal Considerations

The HDSP-2300/-2301/-2302 are available in standard ceramic dual-in-line packages. They are designed for plugging into sockets or soldering into PC boards. The packages may be horizontally or vertically stacked for character arrays of any desired size. The HDSP-2301/-2302 utilize a high output current IC to provide excellent readability in bright ambient lighting. Full power operation ($V_{CC} = V_B = 5.25V$, $V_{COL} = 3.5V$) with worst case thermal resistance from IC junction to ambient of 60°C/watt/device is possible up to ambient temperature of 37°C. For operation above 37°C, the maximum device dissipation should be derated linearly at 16.7 mW/°C (see Figure 5). With an improved thermal design, operation at higher ambient temperatures without derating is possible.

The HDSP-2300 uses a lower power IC, yet achieves excellent readability in indoor ambient lighting. Full power operation up to $T_A = 50°C$ ($V_{CC} = V_B = 5.25V$, $V_{COL} = 3.5V$) is possible by providing a total thermal resistance from IC junction to ambient of 60°C/watt/device maximum. For operation above 50°C, the maximum device dissipation should be derated at 16.7 mW/°C/device (see Figure 2).

Power derating for this family of displays can be achieved in several ways. The power supply voltage can be lowered to a minimum of 4.75V. Column Input Voltage, $V_{COL}$, can be decreased to the recommended minimum values of 2.6V for the HDSP-2300 and 2.75V for the HDSP-2301/-2302. Also, the average drive current can be decreased through pulse width modulation of $V_B$.

The HDSP-2300/-2301/-2302 displays have integral untinted glass lenses. A front panel contrast filter is desirable in most actual display applications. Some suggested filters for the HDSP-2300 are Panelgraphic Rudy Red 60, SGL Homalite H100-1605 and Plexiglass 2423. Filters for high ambient viewing of the HDSP-2301/-2302 include Panelgraphic Gray 10, SGL Homalite H100-1266 Gray, 3M Light Control Film (louvered filters), and Optical Coating Labs Sunguard.

Post solder cleaning may be accomplished using water, Freon/alcohol mixture for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents include Freon TF, Freon TE, Genesolv DI-15, and Genesolv DE-15.

**HEWLETT PACKARD**

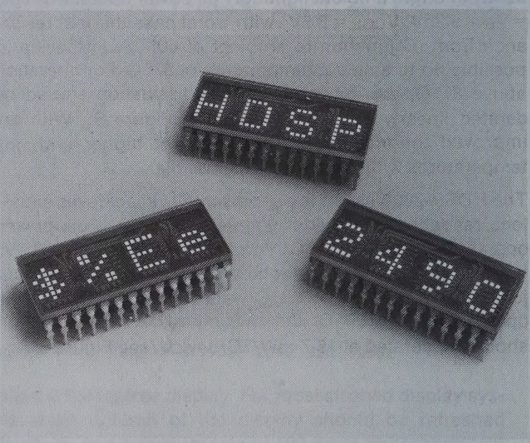
# FOUR CHARACTER 6.9 mm (0.27 INCH) 5x7 ALPHANUMERIC DISPLAYS

STANDARD RED HDSP-2490
YELLOW HDSP-2491
HIGH EFFICIENCY RED HDSP-2492

TECHNICAL DATA FEBRUARY 1982

## Features

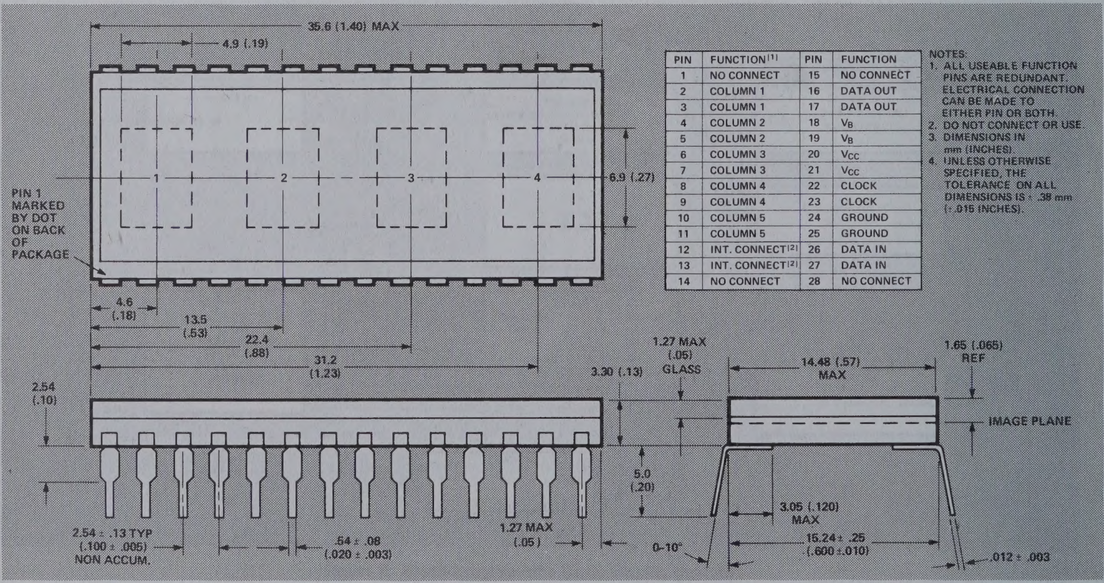
- THREE VERSIONS
  - Standard Red
  - Yellow
  - High Efficiency Red
- INTEGRATED SHIFT REGISTERS WITH CONSTANT CURRENT DRIVERS
- COMPACT CERAMIC PACKAGE
- WIDE VIEWING ANGLE
- END STACKABLE FOUR CHARACTER PACKAGE
- PIN ECONOMY
  - 12 Functional Pins for Four Characters
- TTL COMPATIBLE
- 5 x 7 LED MATRIX DISPLAYS FULL ASCII SET
- CATEGORIZED FOR LUMINOUS INTENSITY
- HDSP-2491 ALSO CATEGORIZED FOR COLOR


HDSP
$%Ee
2490

## Description

The HDSP-2490/-2491/-2492 series of displays are 6.9 mm (0.27 inch) 5 x 7 LED arrays for display of alphanumeric information. These devices are available in standard red, yellow, and high efficiency red. Each four character cluster is contained in a 28 pin dual-in-line package. An on-board SIPO (Serial-In-Parallel-Out) 7-bit shift register associated with each digit controls constant current LED row drivers. Full character display is achieved by external column strobing.

## Package Dimensions


35.6 (1.40) MAX
4.9 (.19)
1
2
3
4
6.9 (.27)
PIN 1 MARKED BY DOT ON BACK OF PACKAGE
4.6 (.18)
13.5 (.53)
22.4 (.88)
31.2 (1.23)
2.54 (.10)
2.54 ± .13 TYP (.100 ± .005) NON ACCUM.
.64 ± .08 (.020 ± .003)
1.27 MAX (.05)
3.30 (.13)
1.27 MAX (.05) GLASS
5.0 (.20)
0-10°
14.48 (.57) MAX
1.65 (.065) REF
IMAGE PLANE
3.05 (.120) MAX
15.24 ± .25 (.600 ± .010)
.012 ± .003

| PIN | FUNCTION[1] | PIN | FUNCTION |
|---|---|---|---|
| 1 | NO CONNECT | 15 | NO CONNECT |
| 2 | COLUMN 1 | 16 | DATA OUT |
| 3 | COLUMN 1 | 17 | DATA OUT |
| 4 | COLUMN 2 | 18 | $V_B$ |
| 5 | COLUMN 2 | 19 | $V_B$ |
| 6 | COLUMN 3 | 20 | $V_{CC}$ |
| 7 | COLUMN 3 | 21 | $V_{CC}$ |
| 8 | COLUMN 4 | 22 | CLOCK |
| 9 | COLUMN 4 | 23 | CLOCK |
| 10 | COLUMN 5 | 24 | GROUND |
| 11 | COLUMN 5 | 25 | GROUND |
| 12 | INT. CONNECT[2] | 26 | DATA IN |
| 13 | INT. CONNECT[2] | 27 | DATA IN |
| 14 | NO CONNECT | 28 | NO CONNECT |

NOTES:
1. ALL USEABLE FUNCTION PINS ARE REDUNDANT. ELECTRICAL CONNECTION CAN BE MADE TO EITHER PIN OR BOTH.
2. DO NOT CONNECT OR USE.
3. DIMENSIONS IN mm (INCHES).
4. UNLESS OTHERWISE SPECIFIED, THE TOLERANCE ON ALL DIMENSIONS IS ± .38 mm (±.015 INCHES).

# Absolute Maximum Ratings (HDSP-2490/-2491/2492)

Supply Voltage $V_{CC}$ to Ground .......... —0.5V to 6.0V
Inputs, Data Out and $V_B$ ................. —0.5V to $V_{CC}$
Column Input Voltage, $V_{COL}$ ............ —0.5V to +6.0V
Free Air Operating
Temperature Range, $T_A$[2] .......... —20° C to +85° C
Storage Temperature Range, $T_S$ ..... —55° C to +100° C
Maximum Allowable Package Dissipation
at $T_A$ = 25° C[1,2,3] ........................ 1.46 Watts
Maximum Solder Temperature 1.59 mm (0.63")
Below Seating Plane t < 5 secs ................ 260° C

# Recommended Operating Conditions (HDSP-2490/-2491/-2492)

| Parameter | Symbol | Min. | Nom. | Max. | Units |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.75 | 5.0 | 5.25 | V |
| Data Out Current, Low State | $I_{OL}$ | | | 1.6 | mA |
| Data Out Current, High State | $I_{OH}$ | | | -0.5 | mA |
| Column Input Voltage, Column On HDSP-2490 | $V_{COL}$ | 2.4 | | 3.5 | V |
| Column Input Voltage, Column On HDSP-2491/-2492 | $V_{COL}$ | 2.75 | | 3.5 | V |
| Setup Time | $t_{setup}$ | 70 | 45 | | ns |
| Hold Time | $t_{hold}$ | 30 | 0 | | ns |
| Width of Clock | $t_{w(Clock)}$ | 75 | | | ns |
| Clock Frequency | $f_{clock}$ | 0 | | 3 | MHz |
| Clock Transition Time | $t_{THL}$ | | | 200 | ns |
| Free Air Operating Temperature Range | $T_A$ | -20 | | 85 | °C |

# Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

**STANDARD RED HDSP-2490**

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK}$ = $V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | | $V_B$ = 2.4V | | 380 | 520 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25° C[6], $V_B$ = 2.4V | | 220 | 370 | | μcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC}$ = $V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | μA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | μA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | μA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | μA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.4V, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.62 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 655 | | nm |
| Dominant Wavelength[7] | | $\lambda_d$ | | | | 639 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 20 | | °C/W/ Device |

*All typical values specified at $V_{CC}$ = 5.0V and $T_A$ = 25° C unless otherwise noted.

**Power dissipation per package with four characters illuminated.

**Notes:**

1. Operation above 85°C ambient is possible provided the following conditions are met. The junction should not exceed 125°C $T_J$ and the case temperature (as measured at pin 1 or the back of the display) should not exceed 100° C $T_C$.
2. The device should be derated linearly above 60° C at 22.2 mW/° C. This derating is based on a device mounted in a socket having a thermal resistance from case to ambient at 25° C/W per device. See Figure 2 for power deratings based on a lower thermal resistance.
3. Maximum allowable dissipation is derived from $V_{CC}$ = $V_B$ = 5.25V, $V_{COL}$ = 3.5V 20 LEDs on per character, 20% DF.

# Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

**YELLOW HDSP-2491**

| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK}$ = $V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | All SR Stages = Logical 1 | $V_B$ = 2.4V | | 380 | 520 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25°C[6], $V_B$ = 2.4V | | 850 | 1400 | | µcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC}$ = $V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | µA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | µA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | µA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | µA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.75, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.67 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 583 | | nm |
| Dominant Wavelength[5,7] | | $\lambda_d$ | | | | 585 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 20 | | °C/W/ Device |

**HIGH EFFICIENCY RED HDSP-2492**

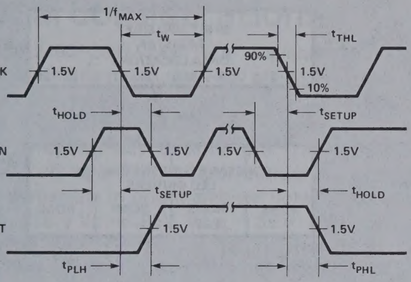
| Description | | Symbol | Test Conditions | | Min. | Typ.* | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | $V_{CC}$ = 5.25V<br>$V_{CLOCK}$ = $V_{DATA}$ = 2.4V<br>All SR Stages = Logical 1 | $V_B$ = 0.4V | | 45 | 60 | mA |
| | | | | $V_B$ = 2.4V | | 73 | 95 | mA |
| Column Current at any Column Input | | $I_{COL}$ | $V_{CC}$ = 5.25 V<br>$V_{COL}$ = 3.5V | $V_B$ = 0.4V | | | 1.5 | mA |
| Column Current at any Column Input | | $I_{COL}$ | All SR Stages = Logical 1 | $V_B$ = 2.4V | | 380 | 520 | mA |
| Peak Luminous Intensity per LED[4,8] (Character Average) | | $I_{vPeak}$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 3.5V<br>$T_i$ = 25°C[6], $V_B$ = 2.4V | | 850 | 1630 | | µcd |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | $V_{CC}$ = $V_{COL}$ = 4.75V | | 2.0 | | | V |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | | | 0.8 | V |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | $V_{CC}$ = 5.25V, $V_{IH}$ = 2.4V | | | 20 | 80 | µA |
| | Data In | $I_{IH}$ | | | | 10 | 40 | µA |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | $V_{CC}$ = 5.25V, $V_{IL}$ = 0.4V | | | -500 | -800 | µA |
| | Data In | $I_{IL}$ | | | | -250 | -400 | µA |
| Data Out Voltage | | $V_{OH}$ | $V_{CC}$ = 4.75V, $I_{OH}$ = -0.5 mA, $V_{COL}$ = 0V | | 2.4 | 3.4 | | V |
| | | $V_{OL}$ | $V_{CC}$ = 4.75V, $I_{OL}$ = 1.6 mA, $V_{COL}$ = 0V | | | 0.2 | 0.4 | V |
| Power Dissipation Per Package** | | $P_D$ | $V_{CC}$ = 5.0V, $V_{COL}$ = 2.75, 17.5% DF<br>15 LEDs on per character, $V_B$ = 2.4V | | | 0.67 | | W |
| Peak Wavelength | | $\lambda_{PEAK}$ | | | | 635 | | nm |
| Dominant Wavelength[7] | | $\lambda_d$ | | | | 626 | | nm |
| Thermal Resistance IC Junction-to-Case | | $R\theta_{J-C}$ | | | | 20 | | °C/W/ Device |

*All typical values specified at $V_{CC}$ = 5.0V and $T_A$ = 25°C unless otherwise noted.

**Power dissipation per package with four characters illuminated.

**Notes:**

4. The characters are categorized for luminous intensity with the intensity category designated by a letter code on the bottom of the package.
5. The HDSP-2491 is categorized for color with the color category designated by a number code on the bottom of the package.
6. $T_i$ refers to the initial case temperature of the device immediately prior to the light measurement.
7. Dominant wavelength $\lambda_d$, is derived from the CIE chromaticity diagram, and represents the single wavelength which defines the color of the device.
8. The luminous sterance of the LED may be calculated using the following relationships:
   $L_v$ (Lux) = $I_v$ (Candela)/A(Metre)$^2$
   $L_v$ (Footlamberts) = $\pi i_v$ (Candela)/A(Foot)$^2$
   A = 5.3 x $10^{-8}$ M$^2$ = 5.8 x $10^{-7}$ (Foot)$^2$


1/f$_{MAX}$
t$_W$
t$_{THL}$
90%
CLOCK
1.5V
1.5V
1.5V
1.5V
10%
t$_{HOLD}$
t$_{SETUP}$
DATA IN
1.5V
1.5V
1.5V
1.5V
t$_{SETUP}$
t$_{HOLD}$
DATA OUT
1.5V
1.5V
t$_{PLH}$
t$_{PHL}$

| Parameter | Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $f_{clock}$ CLOCK Rate | | | | 3 | MHz |
| $t_{PLH}$, $t_{PHL}$ Propagation delay CLOCK to DATA OUT | $C_L = 15pF$<br>$R_L = 2.4K\Omega$ | | | 125 | ns |

Figure 1. Switching Characteristics HDSP-2490/-2491/-2492 ($T_A$ = -20° C to +70° C)

## HDSP-2490/2491/2492

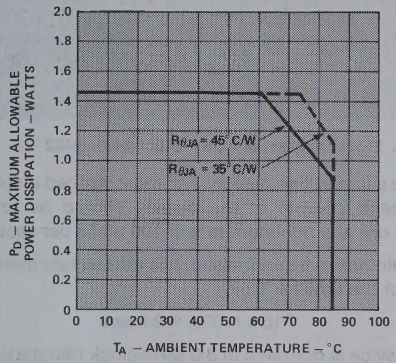


Figure 2. Maximum Allowable Power Dissipation vs. Temperature

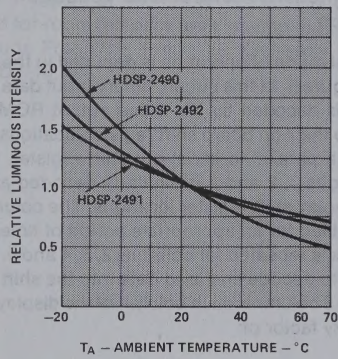


Figure 3. Relative Luminous Intensity vs. Temperature

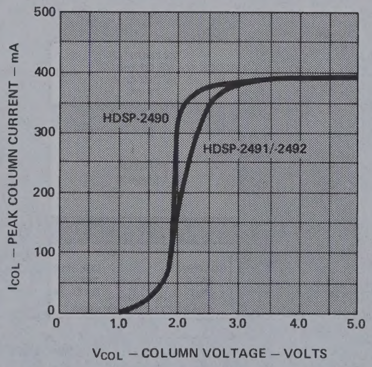


Figure 4. Peak Column Current vs. Column Voltage

# Electrical Description

The HDSP-2490/-2491/-2492 series of four character alphanumeric displays have been designed to allow the user maximum flexibility in interface electronics design. Each four character display module features Data In and Data Out terminals arrayed for easy PC board interconnection such that display strings of up to 80 digits may be driven from a single character generator. Data Out represents the output of the 7th bit of digit number 4 shift register. Shift register clocking occurs on the high to low transition of the Clock input. The like columns of each character in a display cluster are tied to a single pin. Figure 5 is the block diagram for the displays. High true data in the shift register enables the output current mirror driver stage associated with each row of LEDs in the 5 x 7 diode array.

The TTL compatible $V_B$ input may either be tied to $V_{CC}$ for maximum display intensity or pulse width modulated to achieve intensity control and reduction in power consumption.

The normal mode of operation is depicted in the block diagram of Figure 6. In this circuit, binary input data for digit 4, column 1 is decoded by the 7 line output ROM and then loaded into the 7 on board shift register locations 1 through 7 through a parallel-in-serial-out shift register. Column 1 data for digits 3, 2 and 1 is similarly decoded and shifted into the display shift register locations. The column 1 input is now enabled for an appropriate period of time, T. A similar process is repeated for columns 2, 3, 4 and 5. If the time necessary to decode and load data into the shift register is t, then with 5 columns, each column of the display is operating at a duty factor of:

$$\text{D.F.} = \frac{T}{5(t+T)}$$

The time frame, t + T, allotted to each column of the display is generally chosen to provide the maximum duty factor consistent with the minimum refresh rate necessary to achieve a flicker free display. For most strobed display systems, each column of the display should be refreshed (turned on) at a minimum rate of 100 times per second.

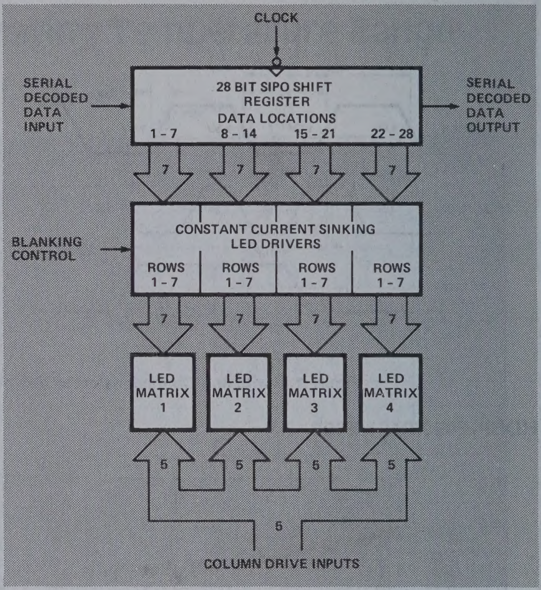

CLOCK
SERIAL DECODED DATA INPUT
28 BIT SIPO SHIFT REGISTER
DATA LOCATIONS
1 - 7
8 - 14
15 - 21
22 - 28
SERIAL DECODED DATA OUTPUT
7
7
7
7
BLANKING CONTROL
CONSTANT CURRENT SINKING LED DRIVERS
ROWS 1 - 7
ROWS 1 - 7
ROWS 1 - 7
ROWS 1 - 7
7
7
7
7
LED MATRIX 1
LED MATRIX 2
LED MATRIX 3
LED MATRIX 4
5
5
5
5
5
COLUMN DRIVE INPUTS

**Figure 5. Block Diagram of HDSP-2490/-2491/-2492**

With columns to be addressed, this refresh rate then gives a value for the time t + T of:

$$1/[5 \times (100)] = 2 \text{ msec.}$$

If the device is operated at 3.0 MHz clock rate maximum, it is possible to maintain t << T. For short display strings, the duty factor will then approach 20%. For longer display strings operation at column duty factors of less than 10% will still provide adequate display intensity in most applications. For further applications information, refer to HP Application Notes 1001 and 966 and Application Bulletin 56.

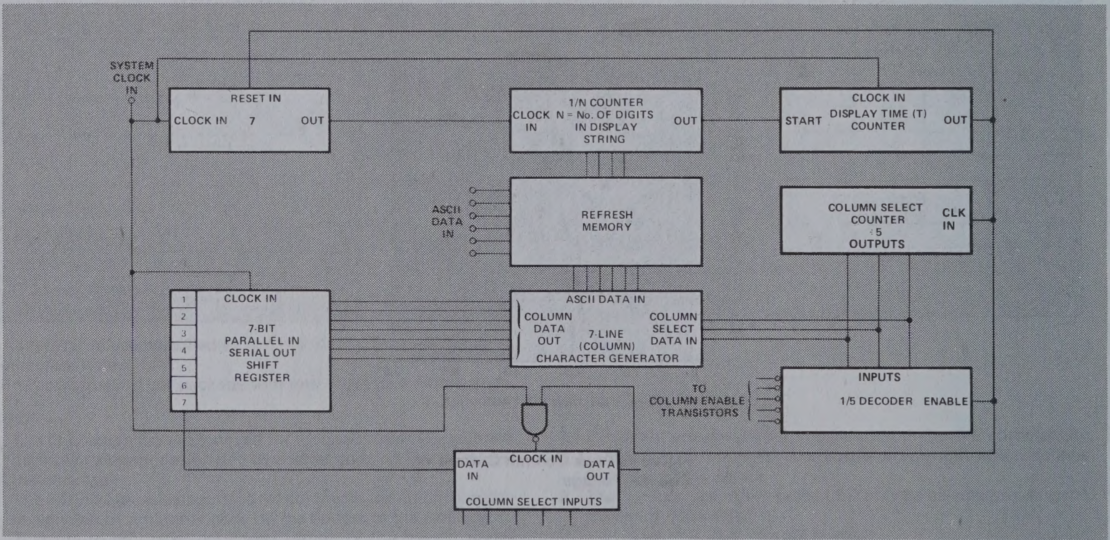

SYSTEM CLOCK IN
RESET IN
CLOCK IN
7
OUT
1/N COUNTER N = No. OF DIGITS IN DISPLAY STRING
CLOCK IN
OUT
CLOCK IN
START
DISPLAY TIME (T) COUNTER
OUT
ASCII DATA IN
REFRESH MEMORY
COLUMN SELECT COUNTER ÷5
OUTPUTS
CLK IN
CLOCK IN
1
2
3
4
5
6
7
7-BIT PARALLEL IN SERIAL OUT SHIFT REGISTER
ASCII DATA IN
COLUMN DATA OUT
7-LINE (COLUMN) CHARACTER GENERATOR
COLUMN SELECT DATA IN
TO COLUMN ENABLE TRANSISTORS
INPUTS
1/5 DECODER
ENABLE
DATA IN
CLOCK IN
DATA OUT
COLUMN SELECT INPUTS

**Figure 6. Block Diagram of a Basic Display System**

# Mechanical and Thermal Considerations

The HDSP-2490/-2491/-2492 are available in standard ceramic dual-in-line packages. They are designed for plugging into sockets or soldering into PC boards. The packages may be horizontally or vertically stacked for character arrays of any desired size. The HDSP-2490/-2491/-2492 utilize a high output current IC to provide excellent readability in bright ambient lighting. Full power operation ($V_{CC} = V_B = 5.25V$, $V_{COL} = 3.5V$) with worst case thermal resistance from IC junction to ambient of 45°C/watt/device is possible up to ambient temperature of 60°C. For operation above 60°C, the maximum device dissipation should be derated linearly at 22.2 mW/°C (see Figure 2). With an improved thermal design, operation at higher ambient temperatures without derating is possible.

Power derating for this family of displays can be achieved in several ways. The power supply voltage can be lowered to a minimum of 4.75V. Column Input Voltage, $V_{COL}$, can be decreased to the recommended minimum values of 2.6V for the HDSP-2490 and 2.75V for the HDSP-2491/-2492. Also, the average drive current can be decreased through pulse width modulation of $V_B$.

The HDSP-2490/-2491/-2492 displays have integral untinted glass lenses. A front panel contrast filter is desirable in most actual display applications. Some suggested filters for the HDSP-2490 are Panelgraphic Rudy Red 60, SGL Homalite H100-1605 and Plexiglass 2423. Filters for high ambient viewing of the HDSP-2491/-2492 include Panelgraphic Gray 10, SGL Homalite H100-1266 Gray, 3M Light Control Film (louvered filters), and Optical Coating Labs Sunguard.

Post solder cleaning may be accomplished using water, Freon/alcohol mixture for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents include Freon TF, Freon TE, Genesolv DI-15, and Genesolv DE-15.

HEWLETT
PACKARD

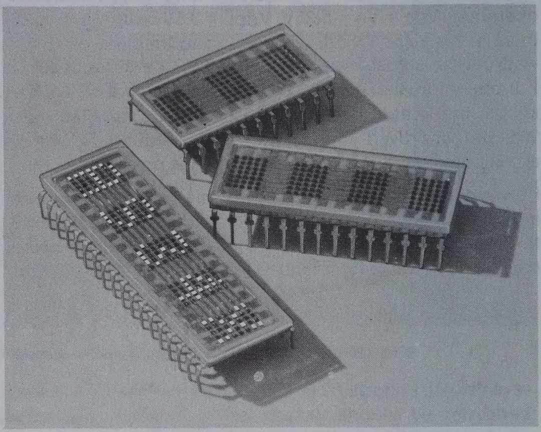
# LED SOLID STATE ALPHANUMERIC INDICATOR

5082-7100
5082-7101
5082-7102

TECHNICAL DATA FEBRUARY 1982

## Features

- 5 x 7 LED MATRIX CHARACTER
- LARGE 6.9 mm (.27 INCH) CHARACTER HEIGHT
- EXTREMELY WIDE TEMP. RANGE
- COMPACT 15.2 mm (.600 INCH) GLASS/CERAMIC DIP
- WIDE VIEWING ANGLE
- RUGGED, SHOCK RESISTANT



## Description

The Hewlett-Packard 5082-7100 Series is an X-Y addressable, 5 x 7 LED Matrix capable of displaying the full alphanumeric character set. This alphanumeric indicator series is available in 3, 4, or 5 character end-stackable clusters. The clusters permit compact presentation of information, ease of character alignment, minimum number of interconnections, and compatibility with multiplexing driving schemes.

Alphanumeric applications include computer terminals, calculators, military equipment and space flight readouts.

The **5082-7100** is a three character cluster.
The **5082-7101** is a four character cluster.
The **5082-7102** is a five character cluster.

## Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Peak Forward Current Per LED (Duration < 1 ms) | $I_{PEAK}$ | | 100 | mA |
| Average Current Per LED | $I_{AVG}$ | | 10 | mA |
| Power Dissipation Per Character (All diodes lit)[1] | $P_D$ | | 700 | mW |
| Operating Temperature, Case | $T_C$ | –55 | 95 | °C |
| Storage Temperature | $T_S$ | –55 | 100 | °C |
| Reverse Voltage Per LED | $V_R$ | | 4 | V |

Note 1: At 25°C Case Temperature; derate 8.5 mW/°C above 25°C.

# Electrical / Optical Characteristics at $T_C = 25°C$

| Parameter | Symbol | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Peak Luminous Intensity Per LED (Character Average) @ Pulse Current of 100mA/LED | $I_v$ (PEAK) | 1.0 | 2.2 | | mcd |
| Reverse Current Per LED @ $V_R$ = 4V | $I_R$ | | 10 | | μA |
| Peak Forward Voltage @ Pulse Current of 50mA/LED | $V_F$ | | 1.7 | 2.0 | V |
| Peak Wavelength | $\lambda_{PEAK}$ | | 655 | | nm |
| Spectral Line Halfwidth | $\Delta\lambda_{1/2}$ | | 30 | | nm |
| Rise and Fall Times [1] | $t_r, t_f$ | | 10 | | ns |

Note 1. Time for a 10% - 90% change of light intensity for step change in current.

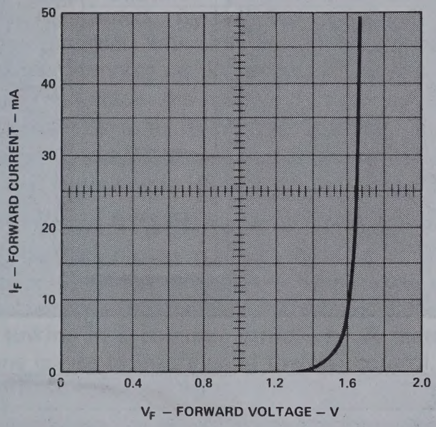


**Figure 1.** Forward Current-Voltage Characteristic.

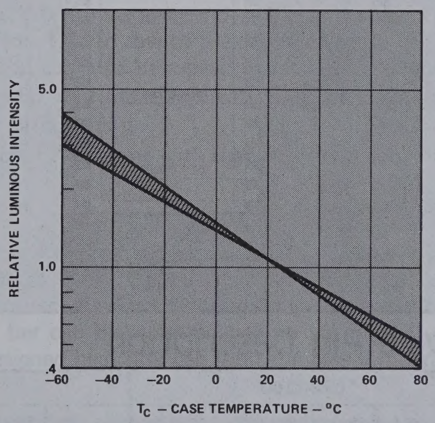


**Figure 2.** Relative Luminous Intensity vs. Case Temperature at Fixed Current Level.

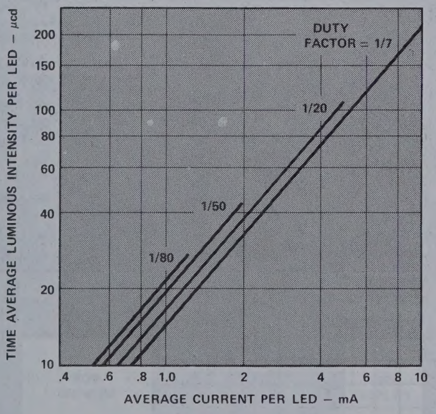


**Figure 3.** Typical Time Average Luminous Intensity per LED vs. Average Current per LED.

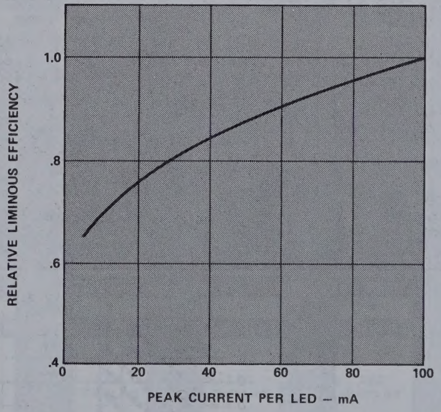
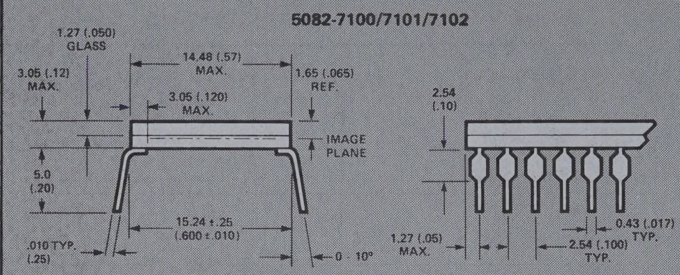


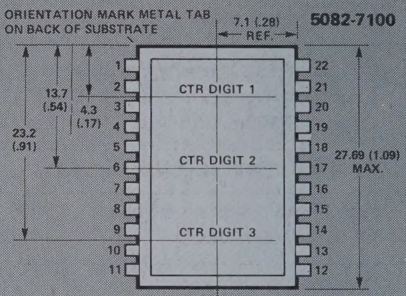
**Figure 4.** Typical Relative Luminous Efficiency vs. Peak Current per LED.

# Package Dimensions and Pin Configurations

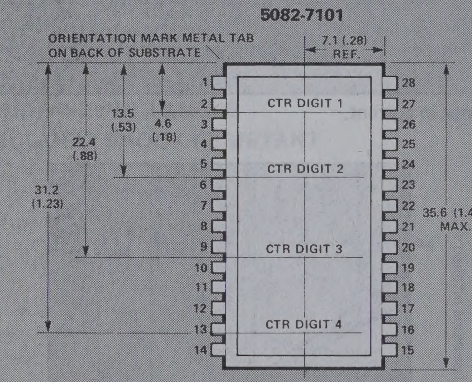
**5082-7100/7101/7102**


1.27 (.050) GLASS
3.05 (.12) MAX.
14.48 (.57) MAX.
1.65 (.065) REF.
3.05 (.120) MAX.
IMAGE PLANE
5.0 (.20)
15.24 ±.25 (.600 ±.010)
.010 TYP. (.25)
0 - 10°
2.54 (.10)
1.27 (.05) MAX.
0.43 (.017) TYP.
2.54 (.100) TYP.

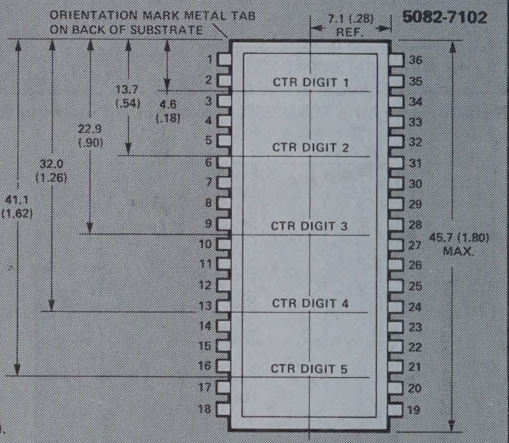
**5082-7100**


ORIENTATION MARK METAL TAB ON BACK OF SUBSTRATE
7.1 (.28) REF.
13.7 (.54)
4.3 (.17)
23.2 (.91)
27.69 (1.09) MAX.
CTR DIGIT 1
CTR DIGIT 2
CTR DIGIT 3
1
2
3
4
5
6
7
8
9
10
11
22
21
20
19
18
17
16
15
14
13
12

**5082-7101**


ORIENTATION MARK METAL TAB ON BACK OF SUBSTRATE
7.1 (.28) REF.
13.5 (.53)
4.6 (.18)
22.4 (.88)
31.2 (1.23)
35.6 (1.40) MAX.
CTR DIGIT 1
CTR DIGIT 2
CTR DIGIT 3
CTR DIGIT 4
1
2
3
4
5
6
7
8
9
10
11
12
13
14
28
27
26
25
24
23
22
21
20
19
18
17
16
15

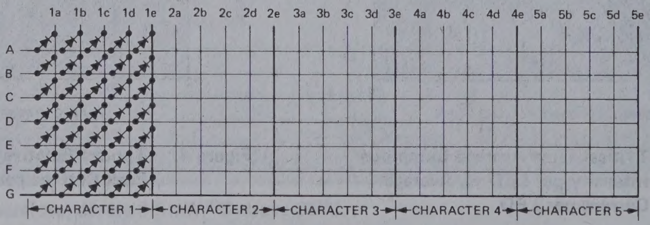
**5082-7102**


ORIENTATION MARK METAL TAB ON BACK OF SUBSTRATE
7.1 (.28) REF.
13.7 (.54)
4.6 (.18)
22.9 (.90)
32.0 (1.26)
41.1 (1.62)
45.7 (1.80) MAX.
CTR DIGIT 1
CTR DIGIT 2
CTR DIGIT 3
CTR DIGIT 4
CTR DIGIT 5
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19

Notes:
1. Dimensions are in millimetres and (inches).
2. Unless otherwise specified, the tolerance on all dimensions is ±0.38mm (±.015 in.).
3. Character Size 6.9 x4.9mm (.27 x .19 in.).

# Device Pin Description

| 5082-7100 | | | | 5082-7101 | | | | 5082-7102 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pin | Function | Pin | Function | Pin | Function | Pin | Function | Pin | Function | Pin | Function |
| 1 | Anode G | 12 | Anode B | 1 | N/C | 15 | Anode C | 1 | N/C | 19 | 5e |
| 2 | 1c | 13 | 3d | 2 | 1c | 16 | 4c | 2 | 1c | 20 | 5c |
| 3 | 1d | 14 | 3b | 3 | 1e | 17 | 4a | 3 | 1e | 21 | 5a |
| 4 | Anode F | 15 | Anode A | 4 | Anode G | 18 | Anode B | 4 | Anode F | 22 | Anode D |
| 5 | Anode E | 16 | 2e | 5 | 2b | 19 | 3e | 5 | 2b | 23 | 4e |
| 6 | 2b | 17 | 2c | 6 | 2d | 20 | 3b | 6 | 2d | 24 | 4c |
| 7 | 2d | 18 | 2a | 7 | Anode D | 21 | 3a | 7 | 2e | 25 | N/C |
| 8 | Anode C | 19 | Anode D | 8 | Anode E | 22 | 2e | 8 | Anode E | 26 | Anode C |
| 9 | 3a | 20 | 1e | 9 | 3c | 23 | 2c | 9 | 3c | 27 | 3d |
| 10 | 3c | 21 | 1b | 10 | 3d | 24 | 2a | 10 | 3e | 28 | 3b |
| 11 | 3e | 22 | 1a | 11 | Anode F | 25 | Anode A | 11 | Anode G | 29 | 3a |
| | | | | 12 | 4b | 26 | 1d | 12 | 4a | 30 | Anode B |
| | | | | 13 | 4d | 27 | 1b | 13 | 4b | 31 | 2c |
| | | | | 14 | 4e | 28 | 1a | 14 | 4d | 32 | 2a |
| | | | | | | | | 15 | N/C | 33 | Anode A |
| | | | | | | | | 16 | 5b | 34 | 1d |
| | | | | | | | | 17 | 5d | 35 | 1b |
| | | | | | | | | 18 | N/C | 36 | 1a |


1a
1b
1c
1d
1e
2a
2b
2c
2d
2e
3a
3b
3c
3d
3e
4a
4b
4c
4d
4e
5a
5b
5c
5d
5e
A
B
C
D
E
F
G
CHARACTER 1
CHARACTER 2
CHARACTER 3
CHARACTER 4
CHARACTER 5

**5082-7100/7101/7102**
**Schematic Wiring Diagram**

# Operating Considerations

## ELECTRICAL

The 5 x 7 matrix of LED's, which make up each character, are X-Y addressable. This allows for a simple addressing, decoding and driving scheme between the display module and customer furnished logic.

There are three main advantages to the use of this type of X-Y addressable array:

1. It is an elementary addressing scheme and provides the least number of interconnection pins for the number of diodes addressed. Thus, it offers maximum flexibility toward integrating the display into particular applications.
2. This method of addressing offers the advantage of sharing the Read-Only-Memory character generator among several display elements. One character generating ROM can be shared over 25 or more 5 x 7 dot matrix characters with substantial cost savings.
3. In many cases equipments will already have a portion of the required decoder/driver (timing and clock circuitry plus buffer storage) logic circuitry available for the display.

To form alphanumeric characters a method called "scanning" or "strobing" is used. Information is addressed to the display by selecting one row of diodes at a time, energizing the appropriate diodes in that row and then proceeding to the next row. After all rows have been excited one at a time, the process is repeated. By scanning through all rows at least 100 times a second, a flicker free character can be produced. When information moves sequentially from row to row of the display (top to bottom) this is row scanning, as illustrated in Figure 5. Information can also be moved from column to column (left to right across the display) in a column scanning mode. For most applications (5 or more characters to share the same ROM) it is more economical to use row scanning.

A much more detailed description of general scanning techniques along with specific circuit recommendations is contained in HP Application Note 931.

## MECHANICAL/THERMAL MOUNTING

The solid state display typically operates with 200 mW power dissipation per character. However, if the operating conditions are such that the power dissipation exceeds the derated maximum allowable value, the device should be heat sunk. The usual mounting technique combines mechanical support and thermal heat sinking in a common structure. A metal strap or bar can be mounted behind the display using silicone grease to insure good thermal control. A well-designed heat sink can limit the case temperature to within 10°C of ambient.

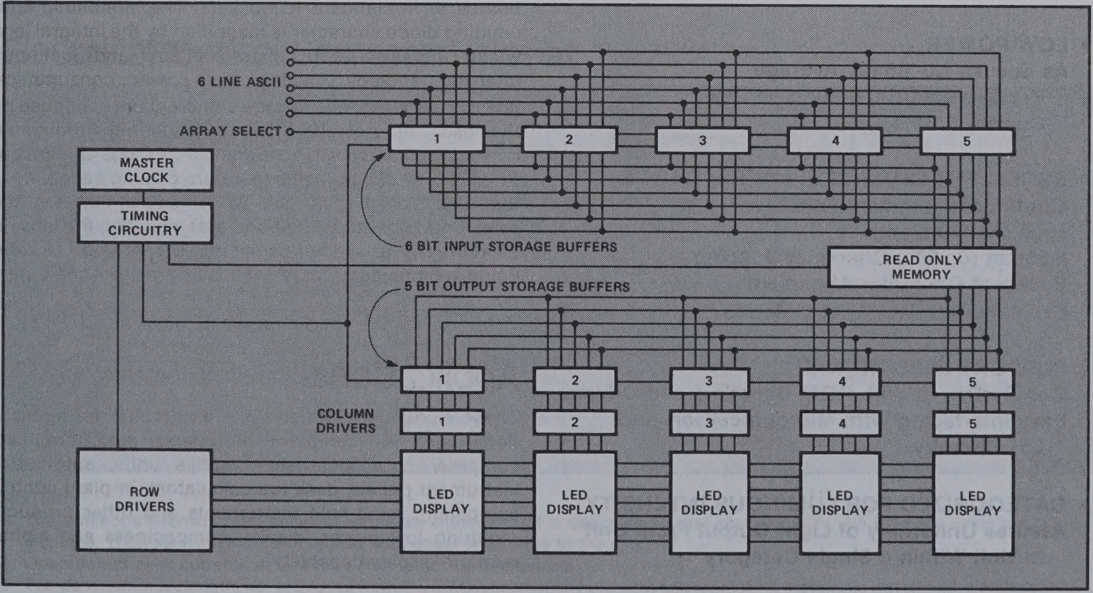


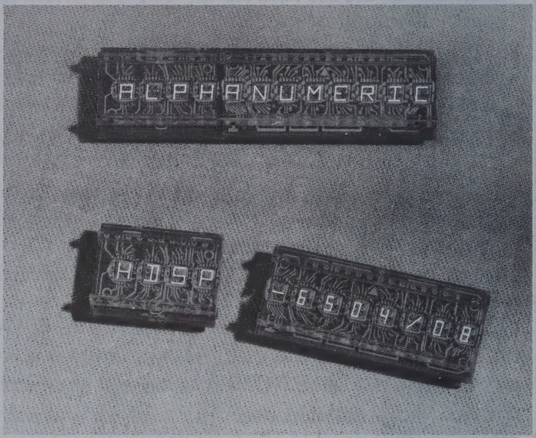
**Figure 5. Row Scanning Block Diagram.**

HEWLETT
PACKARD

# 16 SEGMENT SOLID STATE ALPHANUMERIC DISPLAY

**HDSP-6504**
**HDSP-6508**

TECHNICAL DATA FEBRUARY 1982



## Features

- **ALPHANUMERIC**
  **Displays 64 Character ASCII Set and Special Characters**
- **16 SEGMENT FONT PLUS CENTERED D.P. AND COLON**
- **3.81mm (0.150") CHARACTER HEIGHT**
- **APPLICATION FLEXIBILITY WITH PACKAGE DESIGN**
  **4 and 8 Character Dual-In-Line Packages**
  **End Stackable-On Both Ends for 8 Character and On One End for 4 Character**
  **Sturdy Gold-Plated Leads on 2.54mm (0.100") Centers**
  **Environmentally Rugged Package**
  **Common Cathode Configuration**
- **LOW POWER**
  **As Low as 1.0-1.5mA Average Per Segment Depending on Peak Current Levels**
- **EXCELLENT CHARACTER APPEARANCE**
  **Continuous Segment Font**
  **High On/Off Contrast**
  **6.35mm (0.250") Character Spacing**
  **Excellent Character Alignment**
  **Excellent Readability at 2 Metres**
- **SUPPORT ELECTRONICS**
  **Can Be Driven With ROM Decoders and Drivers**
  **Easy Interfacing With Microprocessors and LSI Circuitry**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  **Assures Uniformity of Light Output From Unit to Unit Within a Single Category**

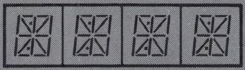
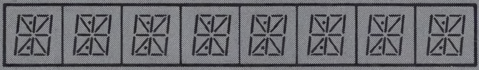
## Description

The HDSP-6504 and HDSP-6508 are 3.81mm (0.150") sixteen segment GaAsP red alphanumeric displays mounted in 4 character and 8 character dual-in-line package configurations that permit mounting on PC boards or in standard IC sockets. The monolithic light emitting diode character is magnified by the integral lens which increases both character size and luminous intensity, thereby making low power consumption possible. The rugged package construction, enhanced by the back fill design, offers extended environmental capabilities compared to the standard PC board/lens type of display package. Its temperature cycling capability is the result of the air gap which exists between the semiconductor chip/wire bond assembly and the lens. In addition to the sixteen segments, a centered D.P. and colon are included. Character spacing yields 4 characters per inch.

## Applications

These alphanumeric displays are attractive for applications such as computer peripherals and terminals, computer base emergency mobile units, automotive instrument panels, desk top calculators, in-plant control equipment, hand-held instruments and other products requiring low power, display compactness and alphanumeric display capability.

## Device Selection Guide

| Characters Per Display | Configuration |  | Part No. HDSP- |
|---|---|---|---|
|  | Device | Package |  |
| 4 |  | (Figure 6) | 6504 |
| 8 |  | (Figure 7) | 6508 |

## Absolute Maximum Ratings

| Symbol | Parameter | Min. | Max. | Units |
|---|---|---|---|---|
| $I_{PEAK}$ | Peak Forward Current Per Segment or DP (Duration ≤ 312μs) |  | 200 | mA |
| $I_{AVG}$ | Average Current Per Segment or DP[1] |  | 7 | mA |
| $P_D$ | Average Power Dissipation Per Character[1,2] |  | 138 | mW |
| $T_A$ | Operating Temperature, Ambient | -40 | 85 | °C |
| $T_S$ | Storage Temperature | -40 | 100 | °C |
| $V_R$ | Reverse Voltage |  | 5 | V |
|  | Solder Temperature at 1.59mm (1/16 inch) below seating plane, t ≤ 3 Seconds |  | 260 | °C |

NOTES:
1. Maximum allowed drive conditions for strobed operation are derived from Figures 1 and 2. See electrical section of operational considerations.
2. Derate linearly above $T_A = 50°C$ at 2.17mW/°C. $P_D$ Max. ($T_A = 85°C$) = 62mW.

## Electrical/Optical Characteristics at $T_A$=25°C

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $I_V$ | Luminous Intensity, Time Average, Character Total with 16 Segments Illuminated [3,4] | $I_{PEAK}$ = 30mA<br>1/16 Duty Factor | 0.40 | 1.65 |  | mcd |
| $V_F$ | Forward Voltage Per Segment or DP | $I_F$ = 30mA<br>(One Segment On) |  | 1.6 | 1.9 | V |
| $\lambda_{PEAK}$ | Peak Wavelength |  |  | 655 |  | nm |
| $\lambda_d$ | Dominant Wavelength [5] |  |  | 640 |  | nm |
| $I_R$ | Reverse Current Per Segment or DP | $V_R$ = 5V |  | 10 |  | μA |
| $\Delta V_F/\Delta °C$ | Temperature Coefficient of Forward Voltage |  |  | -2 |  | mV/°C |
| $R\theta_{J-PIN}$ | Thermal Resistance LED Junction-to-Pin |  |  | 232 |  | °C/W/ Seg |

NOTES:
3. The luminous intensity ratio between segments within a digit is designed so that each segment will have the same luminous sterance. Thus each segment will appear with equal brightness to the eye.
4. Operation at peak currents of less than 7mA is not recommended.
5. The dominant wavelength, λd, is derived from the C.I.E. chromaticity diagram and represents that single wavelength which defines the color of the device, standard red.

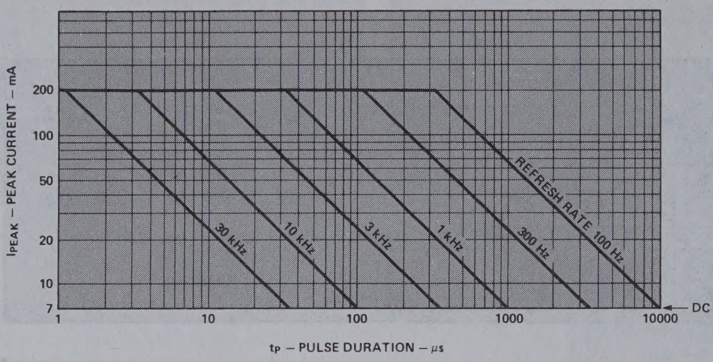


Figure 1. Maximum Allowed Peak Current vs. Pulse Duration. Derate derived operating conditions above $T_A$ = 50°C using Figure 2.

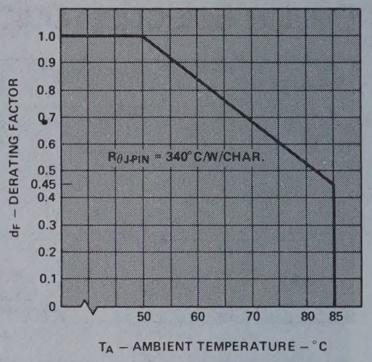


Figure 2. Temperature Derating Factor For Peak Current per Segment vs. Ambient Temperature. $T_J$MAX = 110°C

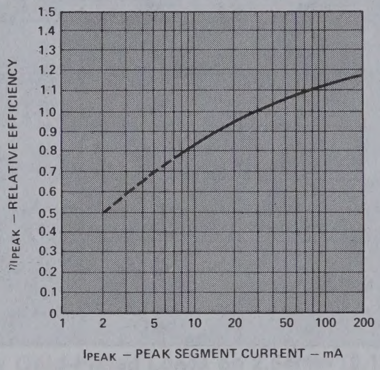


Figure 3. Relative Luminous Efficiency (Luminous Intensity Per Unit Current) vs. Peak Segment Current.

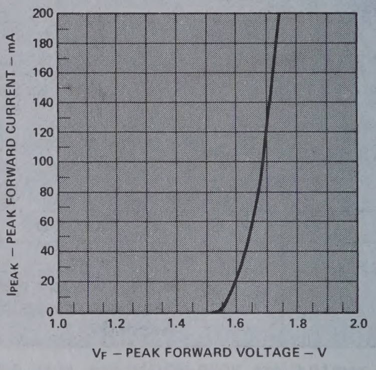


Figure 4. Peak Forward Segment Current vs. Peak Forward Voltage.

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

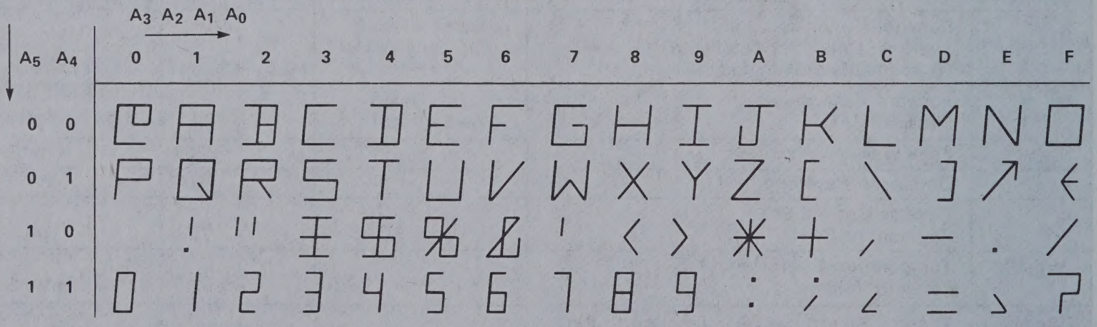
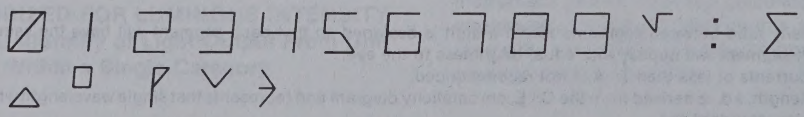
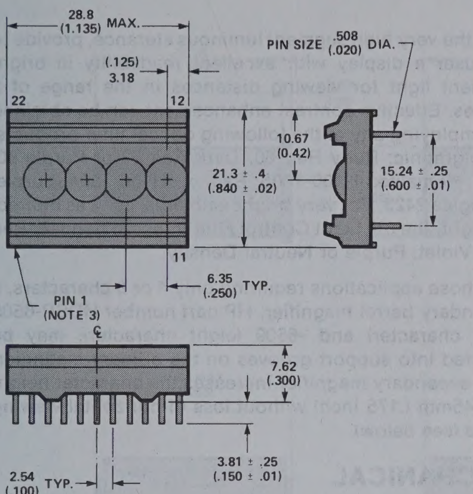

A3 A2 A1 A0
A5 A4
0 1 2 3 4 5 6 7 8 9 A B C D E F
0 0
0 1
1 0
1 1
@ A B C D E F G H I J K L M N O
P Q R S T U V W X Y Z [ \ ] ↑ ←
! " # $ % & ' < > * + , – . /
0 1 2 3 4 5 6 7 8 9 : ; < = > ?

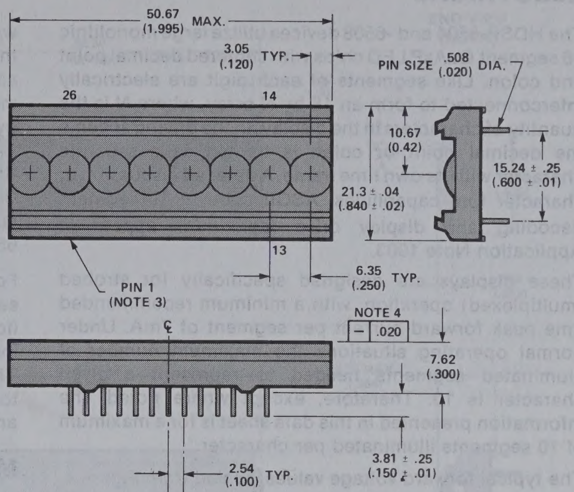
Figure 5. Typical 64 Character ASCII Set.


0 1 2 3 4 5 6 7 8 9 √ ÷ Σ
△ □ ρ ∨ →

Additional Character Font

# Package Dimensions


28.8
(1.135) MAX.
PIN SIZE .508 (.020) DIA.
(.125)
3.18
22
12
10.67
(0.42)
21.3 ± .4
(.840 ± .02)
15.24 ± .25
(.600 ± .01)
11
6.35
(.250) TYP.
PIN 1
(NOTE 3)
℄
7.62
(.300)
3.81 ± .25
(.150 ± .01)
2.54
(.100) TYP.


50.67
(1.995) MAX.
3.05
(.120) TYP.
PIN SIZE .508 (.020) DIA.
26
14
10.67
(0.42)
15.24 ± .25
(.600 ± .01)
21.3 ± .04
(.840 ± .02)
13
6.35
(.250) TYP.
PIN 1
(NOTE 3)
NOTE 4
— .020
℄
7.62
(.300)
3.81 ± .25
(.150 ± .01)
2.54
(.100) TYP.

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES).
2. ALL UNTOLERANCED DIMENSIONS ARE FOR REFERENCE ONLY.
3. PIN 1 IDENTIFIED BY INK DOT ADJACENT TO LEAD.

**Figure 6. HDSP-6504**

**Figure 7. HDSP-6508**

# Magnified Character Font Description

DEVICES
HDSP-6504
HDSP-6508

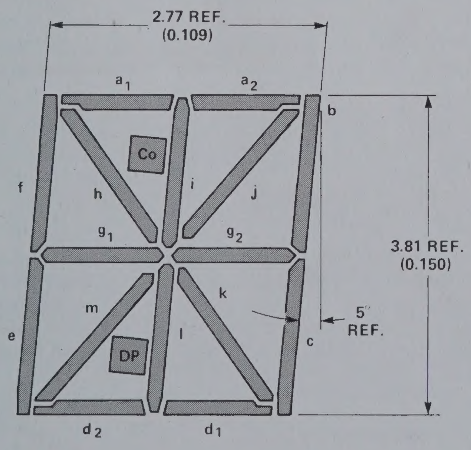

2.77 REF.
(0.109)
a1
a2
b
Co
f
h
i
j
g1
g2
3.81 REF.
(0.150)
m
k
5°
REF.
e
l
c
DP
d2
d1

**Figure 8.**

# Device Pin Description

| Pin No. | Function | | | |
|---|---|---|---|---|
| | HDSP-6504 | | HDSP-6508 | |
| 1 | Anode | Segment $g_1$ | Anode | Segment $g_1$ |
| 2 | Anode | Segment DP | Anode | Segment DP |
| 3 | Cathode | Digit 1 | Cathode | Digit 1 |
| 4 | Anode | Segment $d_2$ | Anode | Segment $d_2$ |
| 5 | Anode | Segment l | Anode | Segment l |
| 6 | Cathode | Digit 3 | Cathode | Digit 3 |
| 7 | Anode | Segment e | Anode | Segment e |
| 8 | Anode | Segment m | Anode | Segment m |
| 9 | Anode | Segment k | Anode | Segment k |
| 10 | Cathode | Digit 4 | Cathode | Digit 4 |
| 11 | Anode | Segment $d_1$ | Anode | Segment $d_1$ |
| 12 | Anode | Segment j | Cathode | Digit 6 |
| 13 | Anode | Segment $C_O$ | Cathode | Digit 8 |
| 14 | Anode | Segment $g_2$ | Cathode | Digit 7 |
| 15 | Anode | Segment $a_2$ | Cathode | Digit 5 |
| 16 | Anode | Segment i | Anode | Segment j |
| 17 | Cathode | Digit 2 | Anode | Segment $C_O$ |
| 18 | Anode | Segment b | Anode | Segment $g_2$ |
| 19 | Anode | Segment $a_1$ | Anode | Segment $a_2$ |
| 20 | Anode | Segment c | Anode | Segment i |
| 21 | Anode | Segment h | Cathode | Digit 2 |
| 22 | Anode | Segment f | Anode | Segment b |
| 23 | | | Anode | Segment $a_1$ |
| 24 | | | Anode | Segment c |
| 25 | | | Anode | Segment h |
| 26 | | | Anode | Segment f |

# Operational Considerations

## ELECTRICAL

The HDSP-6504 and -6508 devices utilize large monolithic 16 segment GaAsP LED chips with centered decimal point and colon. Like segments of each digit are electrically interconnected to form an 18 by N array, where N is the quantity of characters in the display. In the driving scheme the decimal point or colon is treated as a separate character with its own time frame. A detailed discussion of character font capabilities, ASCII code to 18 segment decoding and display drive techniques appear in Application Note 1003.

These displays are designed specifically for strobed (multiplexed) operation, with a minimum recommended time peak forward current per segment of 7mA. Under normal operating situations the maximum number of illuminated segments needed to represent a given character is 10. Therefore, except where noted, the information presented in this data sheet is for a maximum of 10 segments illuminated per character.*

The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design may be calculated using the following $V_F$ model:

$V_F = 1.85\text{V} + I_{PEAK}\ (1.8\Omega)$
For: $30\text{mA} \leq I_{PEAK} \leq 200\text{mA}$
$V_F = 1.58\text{V} + I_{PEAK}\ (10.7\Omega)$
For: $10\text{mA} \leq I_{PEAK} \leq 30\text{mA}$

## OPTICAL AND CONTRAST ENHANCEMENT

Each large monolithic chip is positioned under a separate element of a plastic aspheric magnifying lens, producing a magnified character height of 3.810mm (.150 inch). The aspheric lens provides wide included viewing angles of typically 75 degrees horizontal and 75 degrees vertical with low off axis distortion. These two features, coupled with the very high segment luminous sterance, provide to the user a display with excellent readability in bright ambient light for viewing distances in the range of 2 metres. Effective contrast enhancement can be obtained by employing any of the following optical filter products: Panelgraphic: Ruby Red 60, Dark Red 63 or Purple 90; SGL Homalite: H100-1605 Red or H100-1804 Purple, Plexiglas 2423. For very bright ambients, such as indirect sunlight, the 3M Light Control Film is recommended: Red 655, Violet, Purple or Neutral Density.

For those applications requiring only 4 or 8 characters, a secondary barrel magnifier, HP part number HDSP-6505 (four character) and -6509 (eight character), may be inserted into support grooves on the primary magnifier. This secondary magnifier increases the character height to 4.45mm (.175 inch) without loss of horizontal viewing angle (see below).

## MECHANICAL

These devices are constructed by LED die attaching and wire bonding to a high temperature PC board substrate. A precision molded plastic lens is attached to the PC board and the resulting assembly is backfilled with a sealing epoxy to form an environmentally sealed unit.

The four character and eight character devices can be end stacked to form a character string which is a multiple of a basic four character grouping. As an example, one -6504 and two -6508 devices will form a 20 character string. These devices may be soldered onto a printed circuit board or inserted into 24 and 28 pin DIP LSI sockets. The socket spacing must allow for device end stacking.

Suitable conditions for wave soldering depend upon the specific kind of equipment and procedure used. For more information, consult the local HP Sales Office or Hewlett-Packard Components, Palo Alto, California.

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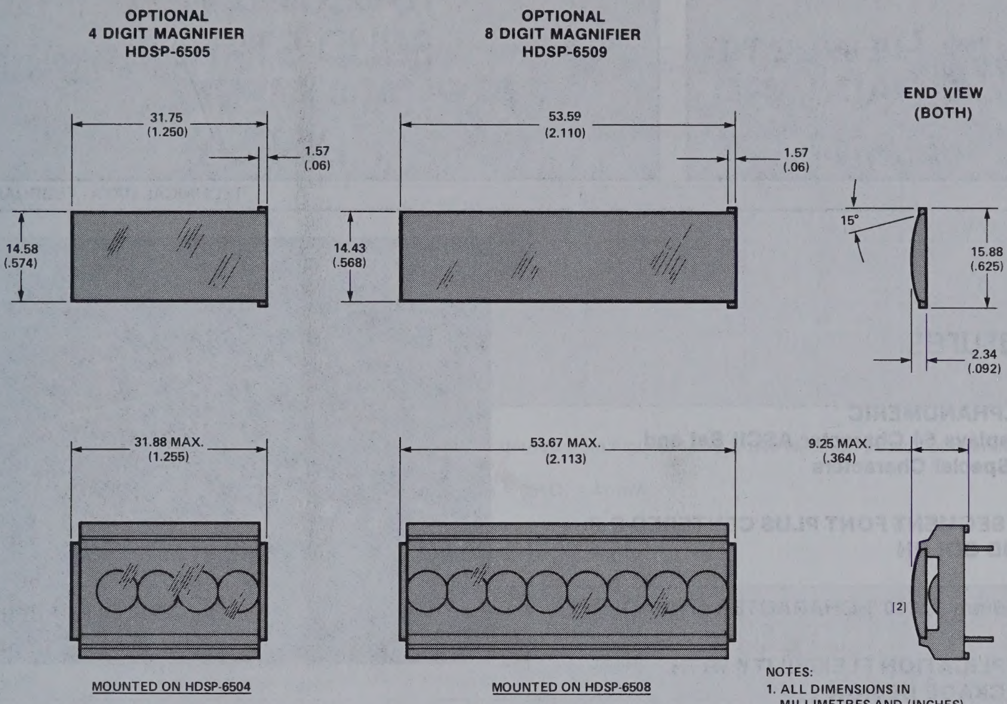
*More than 10 segments may be illuminated in a given character, provided the maximum allowed character power dissipation, temperature derated, is not exceeded.


OPTIONAL
4 DIGIT MAGNIFIER
HDSP-6505
OPTIONAL
8 DIGIT MAGNIFIER
HDSP-6509
END VIEW
(BOTH)
31.75
(1.250)
1.57
(.06)
53.59
(2.110)
1.57
(.06)
15°
14.58
(.574)
14.43
(.568)
15.88
(.625)
2.34
(.092)
31.88 MAX.
(1.255)
53.67 MAX.
(2.113)
9.25 MAX.
(.364)
[2]
MOUNTED ON HDSP-6504
MOUNTED ON HDSP-6508

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES).
2. THIS SECONDARY MAGNIFIER INCREASES THE CHARACTER HEIGHT TO 4.45mm (.175 in.)

**Figure 9. Design Data for Optional Barrel Magnifier in Single Display Applications.**

HEWLETT PACKARD

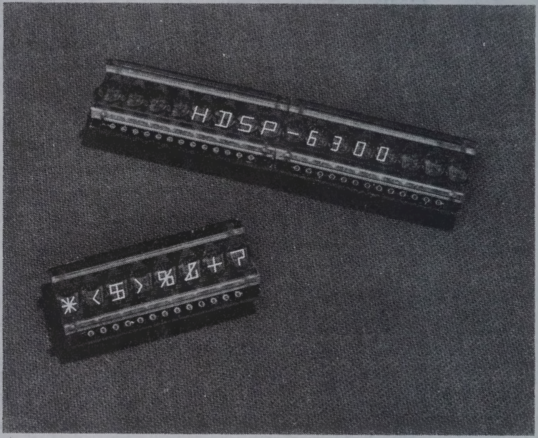
# 16 SEGMENT SOLID STATE ALPHANUMERIC DISPLAY

# HDSP-6300

TECHNICAL DATA FEBRUARY 1982

## Features

- **ALPHANUMERIC**
  **Displays 64 Character ASCII Set and Special Characters**
- **16 SEGMENT FONT PLUS CENTERED D.P. AND COLON**
- **3.56mm (0.140") CHARACTER HEIGHT**
- **APPLICATION FLEXIBILITY WITH PACKAGE DESIGN**
  **8 Character Dual-In-Line Package**
  **End Stackable**
  **Sturdy Leads on 2.54mm (0.100") Centers**
  **Common Cathode Configuration**
- **LOW POWER**
  **As Low as 1.0-1.5mA Average Per Segment Depending on Peak Current Levels**
- **EXCELLENT CHARACTER APPEARANCE**
  **Continuous Segment Font**
  **High On/Off Contrast**
  **5.08mm (0.200") Character Spacing**
  **Excellent Character Alignment**
  **Excellent Readability at 1.5 Metres**
- **SUPPORT ELECTRONICS**
  **Can Be Driven With ROM Decoders and Drivers**
  **Easy Interfacing With Microprocessors and LSI Circuitry**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  **Assures Uniformity of Light Output From Unit to Unit Within a Single Category**



## Description

The HDSP-6300 is a sixteen segment GaAsP red alphanumeric display mounted in an 8 character dual-in-line package configuration that permits mounting on PC boards or in standard IC sockets. The monolithic light emitting diode character is magnified by the integral lens which increases both character size and luminous intensity, thereby making low power consumption possible. The sixteen elements consist of sixteen segments for alphanumeric and special characters plus centered decimal point and colon for good visual aesthetics. Character spacing yields 5 characters per inch.

## Applications

These alphanumeric displays are attractive for applications such as computer peripherals and mobile terminals, desk top calculators, in-plant control equipment, hand-held instruments and other products requiring low power, display compactness and alphanumeric display capability.

# Absolute Maximum Ratings

| Symbol | Parameter | Min. | Max. | Units |
|---|---|---|---|---|
| $I_{PEAK}$ | Peak Forward Current Per Segment or DP (Duration ≤ 417μs) | | 150 | mA |
| $I_{AVG}$ | Average Current Per Segment or DP[1] | | 6.25 | mA |
| $P_D$ | Average Power Dissipation Per Character[1,2] | | 133 | mW |
| $T_A$ | Operating Temperature, Ambient | -40 | 85 | °C |
| $T_S$ | Storage Temperature | -40 | 100 | °C |
| $V_R$ | Reverse Voltage | | 5 | V |
| | Solder Temperature at 1.59mm (1/16 inch) below seating plane, t ≤ 5 Seconds | | 260 | °C |

NOTES:

1. Maximum allowed drive conditions for strobed operation are derived from Figures 1 and 2. See electrical section of operational considerations.
2. Derate linearly above $T_A = 50°C$ at 2.47 mW/°C. $P_D$ Max. ($T_A = 85°C$) = 47 mW.

# Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| $I_V$ | Luminous Intensity, Time Average, Character Total with 16 Segments Illuminated[3,4] | $I_{PEAK}$ = 24mA<br>1/16 Duty Factor | 400 | 1200 | | μcd |
| $V_F$ | Forward Voltage Per Segment or DP | $I_F$ = 24mA<br>(One Segment On) | | 1.6 | 1.9 | V |
| $\lambda_{PEAK}$ | Peak Wavelength | | | 655 | | nm |
| $\lambda_d$ | Dominant Wavelength[5] | | | 640 | | nm |
| $I_R$ | Reverse Current Per Segment or DP | $V_R$ = 5V | | 10 | | μA |
| $R\theta_{J-PIN}$ | Thermal Resistance LED Junction-to-Pin per Character | | | 250 | | °C/W/Char. |

NOTES:

3. The luminous intensity ratio between segments within a digit is designed so that each segment will have the same luminous sterance. Thus each segment will appear with equal brightness to the eye.
4. Operation at peak currents of less than 7mA is not recommended.
5. The dominant wavelength, λd, is derived from the C.I.E. chromaticity diagram and represents that single wavelength which defines the color of the device, standard red.

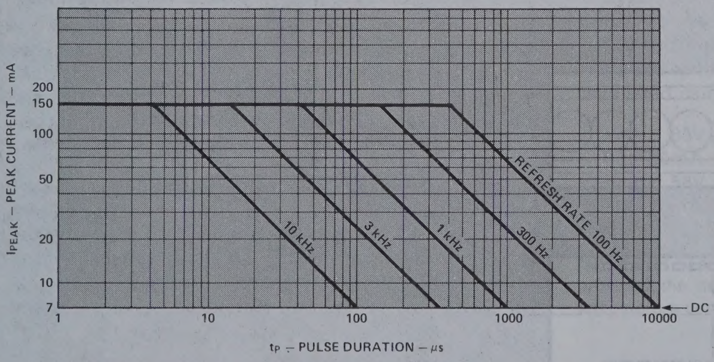


**Figure 1. Maximum Allowed Peak Current vs. Pulse Duration. Derate derived operating conditions above $T_A = 50°C$ using Figure 2.**

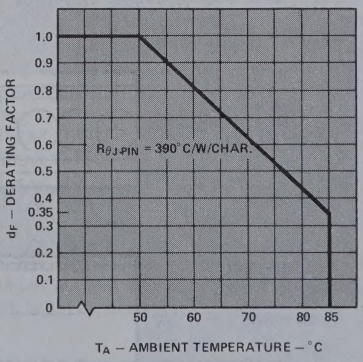


**Figure 2. Temperature Derating Factor For Peak Current per Segment vs. Ambient Temperature. $T_{JMAX} = 110°C$**

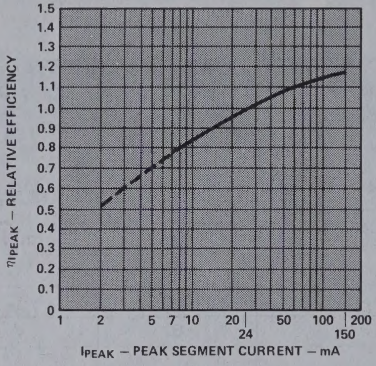


Figure 3. Relative Luminous Efficiency (Luminous Intensity Per Unit Current) vs. Peak Segment Current.

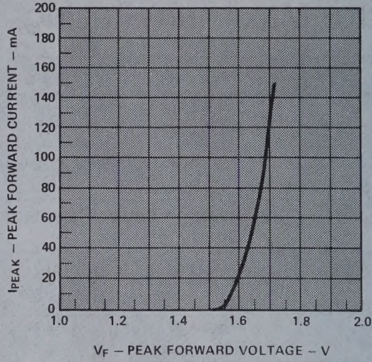


Figure 4. Peak Forward Segment Current vs. Peak Forward Voltage.

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

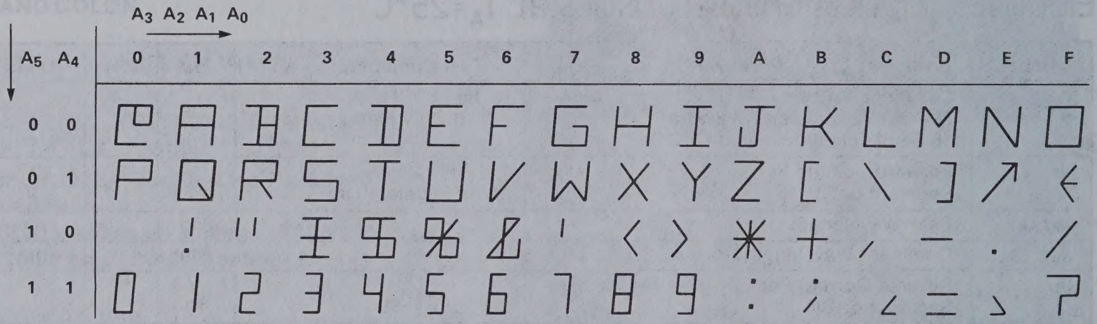
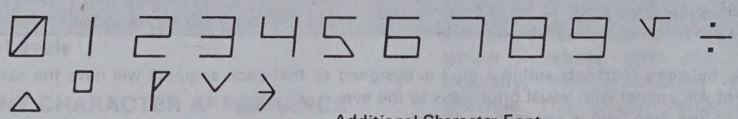
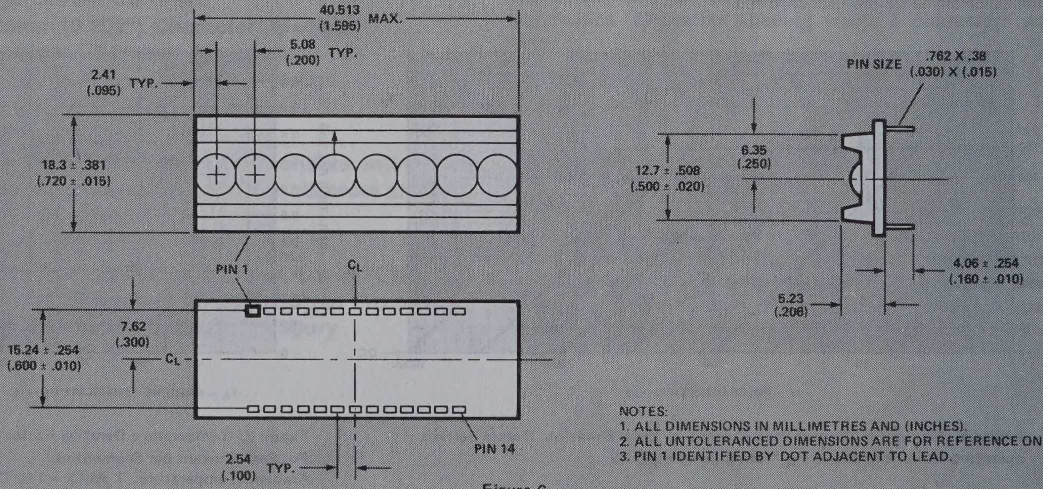

$A_3$ $A_2$ $A_1$ $A_0$
$A_5$ $A_4$
0
1
2
3
4
5
6
7
8
9
A
B
C
D
E
F
0 0
0 1
1 0
1 1

Figure 5. Typical 64 Character ASCII Set.



Additional Character Font


40.513 (1.595) MAX.
5.08 (.200) TYP.
2.41 (.095) TYP.
18.3 ± .381 (.720 ± .015)
PIN 1
$C_L$
7.62 (.300)
15.24 ± .254 (.600 ± .010)
$C_L$
PIN 14
2.54 (.100) TYP.
PIN SIZE .762 X .38 (.030) X (.015)
6.35 (.250)
12.7 ± .508 (.500 ± .020)
4.06 ± .254 (.160 ± .010)
5.23 (.206)

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES).
2. ALL UNTOLERANCED DIMENSIONS ARE FOR REFERENCE ONLY.
3. PIN 1 IDENTIFIED BY DOT ADJACENT TO LEAD.

Figure 6.

## Magnified Character Font Description

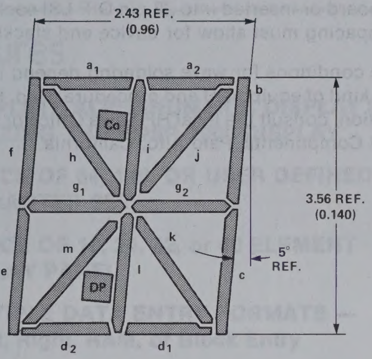


Figure 7.

## Device Pin Description

| Pin No. | Function | |
|---|---|---|
| 1 | Anode | Segment K |
| 2 | Anode | Segment $D_1$ |
| 3 | Anode | Segment C |
| 4 | Cathode | Digit 1 |
| 5 | Cathode | Digit 2 |
| 6 | Cathode | Digit 3 |
| 7 | Cathode | Digit 4 |
| 8 | Anode | Segment L |
| 9 | Anode | Segment $G_2$ |
| 10 | Anode | Segment E |
| 11 | Anode | Segment M |
| 12 | Anode | Segment $D_2$ |
| 13 | Anode | Segment DP |
| 14 | Anode | Segment $A_2$ |
| 15 | Anode | Segment I |
| 16 | Anode | Segment J |
| 17 | Cathode | Digit 8 |
| 18 | Cathode | Digit 7 |
| 19 | Cathode | Digit 6 |
| 20 | Cathode | Digit 5 |
| 21 | Anode | Segment $C_o$ |
| 22 | Anode | Segment $G_1$ |
| 23 | Anode | Segment B |
| 24 | Anode | Segment F |
| 25 | Anode | Segment H |
| 26 | Anode | Segment $A_1$ |

## Operational Considerations

### ELECTRICAL

The HDSP-6300 device utilizes large monolithic 16 segment plus centered decimal point and colon GaAsP LED chips. Like segments of each digit are electrically interconnected to form an 18 by N array, where N is the quantity of characters in the display. In the driving scheme the decimal point or colon is treated as a separate character with its own time frame. A detailed discussion of character font capabilities, ASCII code to 16 segment decoding, and display drive techniques will appear in a forthcoming application note.

This display is designed specifically for strobed (multiplexed) operation, with a minimum recommended peak forward current per segment of 7.0 mA. Under normal operating situations the maximum number of illuminated segments needed to represent a given character is 10. Therefore, except where noted, the information presented in this data sheet is for a maximum of 10 segments illuminated per character.*

The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design may be calculated using the following $V_F$ model:

$V_F = 1.85V + I_{PEAK}\ (1.8\Omega)$
For $30mA \le I_{PEAK} \le 150mA$
$V_F = 1.58V + I_{PEAK}\ (10.7\Omega)$
For $10mA \le I_{PEAK} \le 30mA$

---

*More than 10 segments may be illuminated in a given character, provided the maximum allowed character power dissipation, temperature derated, is not exceeded.

## OPTICAL AND CONTRAST ENHANCEMENT

Each large monolithic chip is positioned under a separate element of a plastic aspheric magnifying lens producing a magnified character height of 3.56mm (0.140 inch). The aspheric lens provides wide included viewing angles of 60 degrees horizontal and 55 degrees vertical with low off axis distortion. These two features, coupled with the very high segment luminous sterance, provide to the user a display with excellent readability in bright ambient light for viewing distances in the range of 1.5 metres. Effective contrast enhancement can be obtained by employing an optical filter product such as Panelgraphic Ruby Red 60, Dark Red 63 or Purple 90; SGL Homalite H100-1605 Red or H100-1804 Purple; or Plexiglas 2423. For very bright ambients, such as indirect sunlight, the 3M Red 655 or Neutral Density Light Control Film is recommended.

## MECHANICAL

This device is constructed by LED die attaching and wire bonding to a high temperature PC board substrate. A precision molded plastic lens is attached to the PC board.

The HDSP-6300 can be end stacked to form a character string which is a multiple of a basic eight character grouping. These devices may be soldered onto a printed circuit board or inserted into 28 pin DIP LSI sockets. The socket spacing must allow for device end stacking.

Suitable conditions for wave soldering depend upon the specific kind of equipment and procedure used. For more information, consult the local HP Sales Office or Hewlett-Packard Components, Palo Alto, California.

HEWLETT PACKARD

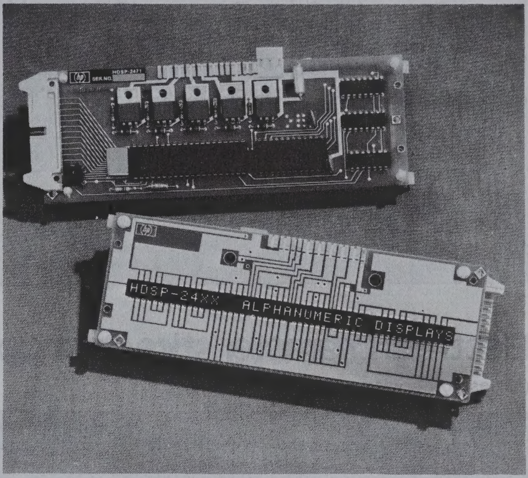
# 5 x 7 DOT MATRIX ALPHANUMERIC DISPLAY SYSTEM

HDSP - 2416
HDSP - 2424
HDSP - 2432
HDSP - 2440
HDSP - 2470
HDSP - 2471
HDSP - 2472

TECHNICAL DATA FEBRUARY 1982

## Features

- **COMPLETE ALPHANUMERIC DISPLAY SYSTEM UTILIZING THE HDSP-2000 DISPLAY**
- **CHOICE OF 64, 128, OR USER DEFINED ASCII CHARACTER SET**
- **CHOICE OF 16, 24, 32, or 40 ELEMENT DISPLAY PANEL**
- **MULTIPLE DATA ENTRY FORMATS — Left, Right, RAM, or Block Entry**
- **EDITING FEATURES THAT INCLUDE CURSOR, BACKSPACE, FORWARDSPACE, INSERT, DELETE, AND CLEAR**
- **DATA OUTPUT CAPABILITY**
- **SINGLE 5.0 VOLT POWER SUPPLY**
- **TTL COMPATIBLE**
- **EASILY INTERFACED TO A KEYBOARD OR A MICROPROCESSOR**



## Description

The HDSP-24XX series of alphanumeric display systems provides the user with a completely supported 5 x 7 dot matrix display panel. These products free the user's system from display maintenance and minimize the interaction normally required for alphanumeric displays. Each alphanumeric display system is composed of two component parts:

1. An alphanumeric display controller which consists of a preprogrammed microprocessor plus associated logic, which provides decode, memory, and drive signals necessary to properly interface a user's system to an HDSP-2000 display. In addition to these basic display support operations, the controller accepts data in any of four data entry formats and incorporates several powerful editing routines.
2. A display panel which consists of HDSP-2000 displays matched for luminous intensity and mounted on a P.C. board designed to have low thermal resistance.

These alphanumeric display systems are attractive for applications such as data entry terminals, instrumentation, electronic typewriters, and other products which require an easy to use 5 x 7 dot matrix alphanumeric display system.

| **PART NUMBER** | **DESCRIPTION** |
|---|---|
| **Display Boards** | |
| HDSP-2416 | Single-line 16 character display panel utilizing the HDSP-2000 display |
| HDSP-2424 | Single-line 24 character display panel utilizing the HDSP-2000 display |
| HDSP-2432 | Single-line 32 character display panel utilizing the HDSP-2000 display |
| HDSP-2440 | Single-line 40 character display panel utilizing the HDSP-2000 display |
| **Controller Boards** | |
| HDSP-2470 | HDSP-2000 display interface incorporating a 64 character ASCII decoder |
| HDSP-2471 | HDSP-2000 display interface incorporating a 128 character ASCII decoder |
| HDSP-2472 | HDSP-2000 display interface without ASCII decoder. Instead, a 24 pin socket is provided to accept a custom 128 character set from a user programmed 1K x 8 PROM. |

When ordering, specify one each of the Controller Board and the Display Board for each complete system.

# HDSP-2470/-2471/-2472

## Absolute Maximum Ratings

$V_{CC}$ .................................... -0.5V to 6.0V

Operating Temperature Range,
Ambient ($T_A$) ....................... 0°C to 70°C

Storage Temperature Range ($T_S$) .... -55°C to 100°C

Voltage Applied to any Input or Output ..-0.5V to 6.0V

$I_{SOURCE}$ Continuous for any Column
Driver .......... 5.0 Amps (60 sec. max. duration)

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.75 | 5.25 | V |
| Data Out | $I_{OL}$ | | 0.4 | mA |
| | $I_{OH}$ | | -20 | µA |
| Ready, Data Valid, Column On, Display Data | $I_{OL}$ | | 1.6 | mA |
| | $I_{OH}$ | | -40 | µA |
| Clock | $I_{OL}$ | | 10.0 | mA |
| | $I_{OH}$ | | -1.0 | mA |
| $\text{Column}_{1-5}$ | $I_{SOURCE}$ | | -5.0 | A |

## Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Supply Current[1] | $I_{CC}$ | | | 400 | mA | $V_{CC}$ = 5.25V Column On and All Outputs Open |
| Input Threshold High (except Reset) | $V_{IH}$ | 2.0 | | | V | $V_{CC}$ = 5.0V ± .25V |
| Input Threshold High — Reset[2] | $V_{IH}$ | 3.0 | | | V | $V_{CC}$ = 5.0V ± .25V |
| Input Threshold Low — All Inputs | $V_{IL}$ | | | 0.8 | V | $V_{CC}$ = 5.0V ± .25V |
| Data Out Voltage | $V_{OH}$Data | 2.4 | | | V | $I_{OH}$ = -20µA $V_{CC}$ = 4.75V |
| | $V_{OL}$Data | | | 0.5 | V | $I_{OL}$ = 0.4mA $V_{CC}$ = 4.75V |
| Clock Output Voltage | $V_{OH}$Clk | 2.4 | | | V | $I_{OH}$ = -1000µA $V_{CC}$ = 4.75V |
| | $V_{OL}$Clk | | | 0.5 | V | $I_{OL}$ = 10.0mA $V_{CC}$ = 4.75V |
| Ready, Display Data, Data Valid, Column on Output Voltage | $V_{OH}$ | 2.4 | | | V | $I_{OH}$ = -40µA $V_{CC}$ = 4.75V |
| | $V_{OL}$ | | | 0.5 | V | $I_{OL}$ = 1.6mA $V_{CC}$ = 4.75V |
| Input Current,[3] All Inputs Except Reset, Chip Select, $D_7$ | $I_{IH}$ | | | -0.3 | mA | $V_{IH}$ = 2.4V $V_{CC}$ = 5.25V |
| | $I_{IL}$ | | | -0.6 | mA | $V_{IL}$ = 0.5V $V_{CC}$ = 5.25V |
| $\overline{\text{Reset}}$ Input Current | $I_{IH}$ | | | -0.3 | mA | $V_{IH}$ = 3.0V $V_{CC}$ = 5.25V |
| | $I_{IL}$ | | | -0.6 | mA | $V_{IL}$ = 0.5V $V_{CC}$ = 5.25V |
| Chip Select, $D_7$ Input Current | $I_I$ | -10 | | +10 | µA | $0 < V_I < V_{CC}$ |
| Column Output Voltage | $V_{OL}$COL | 2.6 | 3.2 | | V | $I_{OUT}$ = -5.0A $V_{CC}$ = 5.00V |

NOTES:

1. See Figure 11 for total system supply current.
2. External reset may be initiated by grounding Reset with either a switch or open collector TTL gate for a minimum time of 50ms. For Power On Reset to function properly, $V_{CC}$ power supply should turn on at a rate > 100V/s.
3. Momentary peak surge currents may exist on these lines. However, these momentary currents will not interfere with proper operation of the HDSP-2470/1/2.

# HDSP-2416/-2424/-2432/-2440

## Absolute Maximum Ratings

Supply Voltage $V_{CC}$ to Ground ......... -0.5V to 6.0V
Inputs, Data Out and $V_B$ ............... -0.5V to $V_{CC}$
Column Input Voltage, $V_{COL}$ ......... -0.5V to +6.0V
Free Air Operating Temperature Range, $T_A$[1] ........................ 0°C to +55°C
Storage Temperature Range, $T_S$ .... -55°C to +100°C

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Norm. | Max. | Units |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.75 | 5.0 | 5.25 | V |
| Column Input Voltage, Column On | $V_{COL}$ | 2.6 | | | V |
| Setup Time | $t_{SETUP}$ | 70 | 45 | | ns |
| Hold Time | $t_{HOLD}$ | 30 | 0 | | ns |
| Width of Clock | $t_{W(CLOCK)}$ | 75 | | | ns |
| Clock Frequency | $f_{CLOCK}$ | 0 | | 3 | MHz |
| Clock Transition Time | $t_{THL}$ | | | 200 | ns |
| Free Air Operating[1] Temperature Range | $T_A$ | 0 | | 55 | °C |

## Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

| Parameter | | Symbol | Min. | Typ.* | Max. | Units | Conditions | |
|---|---|---|---|---|---|---|---|---|
| Supply Current | | $I_{CC}$ | | 45n | 60n[2] | mA | $V_{CC} = 5.25V$<br>$V_{CLOCK}=V_{DATA}=2.4V$<br>All SR Stages = Logical 1 | $V_B = 0.4V$ |
| | | | | 73n | 95n | mA | | $V_B = 2.4V$ |
| Column Current at any Column Input | | $I_{COL}$ | | | 1.5n | mA | $V_{CC} = V_{COL} = 5.25V$<br>All SR Stages = Logical 1 | $V_B = 0.4V$ |
| | | $I_{COL}$ | | 335n | 410n | mA | | $V_B = 2.4V$ |
| Peak Luminous Intensity per LED (Character Average) | | $I_{V\ PEAK}$ | 105 | 200 | | µcd | $V_{CC} = 5.0V$, $V_{COL} = 3.5V$<br>$T_j = 25°C$[3], $V_B = 2.4V$ | |
| $V_B$, Clock or Data Input Threshold High | | $V_{IH}$ | 2.0 | | | V | $V_{CC} = V_{COL} = 4.75V$ | |
| $V_B$, Clock or Data Input Threshold Low | | $V_{IL}$ | | | 0.8 | V | | |
| Input Current Logical 1 | $V_B$, Clock | $I_{IH}$ | | | 80 | µA | $V_{CC} = 5.25V$, $V_{IH} = 2.4V$ | |
| | Data In | $I_{IH}$ | | | 40 | µA | | |
| Input Current Logical 0 | $V_B$, Clock | $I_{IL}$ | | -500 | -800 | µA | $V_{CC} = 5.25V$, $V_{IL} = 0.4V$ | |
| | Data In | $I_{IL}$ | | -250 | -400 | µA | | |
| Power Dissipation Per Board[4] | | $P_D$ | | 0.66n | | W | $V_{CC} = 5.0V$, $V_{COL} = 2.6V$<br>15 LED's on per Character,<br>$V_B = 2.4V$ | |

*All typical values specified at $V_{CC} = 5.0V$ and $T_A = 25°C$ unless otherwise noted.

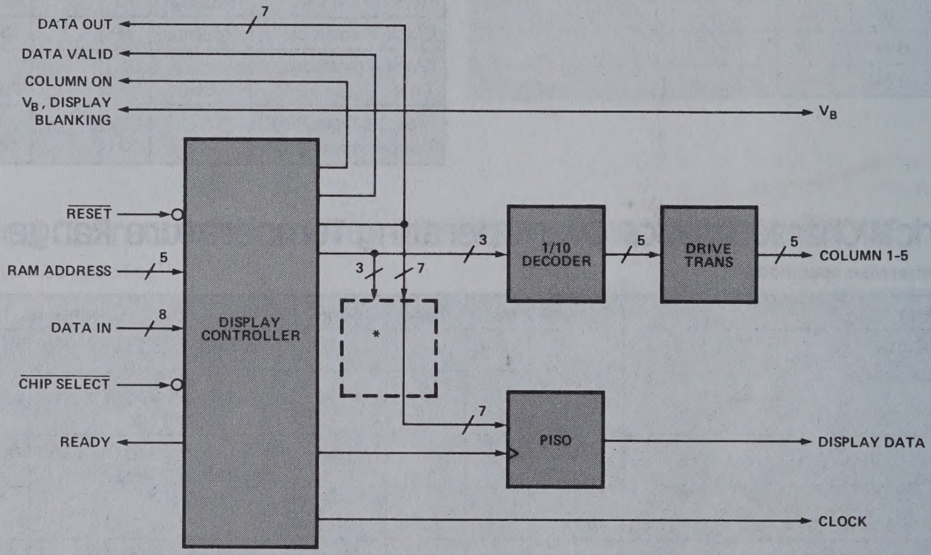
NOTES:

1. Operation above 55°C (70°C MAX) may be achieved by the use of forced air (150 fpm normal to component side of HDSP-247X controller board at sea level). Operation down to -20°C is possible in applications that do not require the use of HDSP-2470/-2471/-2472 controller boards.
2. n = number of HDSP-2000 packages
   HDSP-2416 n = 4
   HDSP-2424 n = 6
   HDSP-2432 n = 8
   HDSP-2440 n = 10
3. Tj refers to initial case temperature immediately prior to the light measurement.
4. Power dissipation with all characters illuminated.

## System Overview

The HDSP-2470/-2471/-2472 Alphanumeric Display Controllers provide the interface between any ASCII based Alphanumeric System and the HDSP-2000 Alphanumeric Display. ASCII data is loaded into the system by means of any one of four data entry modes — Left, Right, RAM or Block Entry. This ASCII data is stored in the internal RAM memory of the system. The system refreshes HDSP-2000 displays from 4 to 48 characters with the decoded data.

The user interfaces to any of the systems through eight DATA IN inputs, five ADDRESS inputs (RAM mode), a CHIP SELECT input, RESET input, seven DATA OUT outputs, a READY output, DATA VALID output, and a COLUMN ON output. A low level on the RESET input clears the display and initializes the system. A low level on the CHIP SELECT input causes the system to load data from the DATA IN and ADDRESS inputs into the system. The controller outputs a status word, cursor address and 32 ASCII data characters through the DATA OUT outputs and DATA VALID output during the time the system is waiting to refresh the next column of the display. The COLUMN ON output can be used to synchronize the DATA OUT function. A block diagram for the HDSP-2470/-2471/-2472 systems is shown in Figure 1.



*CHARACTER GENERATOR FOR HDSP-2471,
SOCKET FOR 1K X 8 PROM FOR HDSP-2472.

**Figure 1. Block Diagram for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**

The system interfaces to the HDSP-2000 display through five COLUMN outputs, a CLOCK output, DISPLAY DATA output, and the COLUMN ON output. The user should connect DISPLAY DATA to DATA IN of the leftmost HDSP-2000 cluster and cascade DATA OUT to DATA IN of all HDSP-2000 clusters. COLUMN outputs from the system are connected to the COLUMN inputs of all HDSP-2000 clusters. The HDSP-24XX Series display boards are designed to interconnect directly with the HDSP-247X Series display controllers. The COLUMN outputs can source enough current to drive up to 48 characters of the HDSP-2000 display. Pulse width modulation of display luminous intensity can be provided by connecting COLUMN ON to the input of a monostable multivibrator and the output of the monostable multivibrator to the $V_B$ inputs of the HDSP-2000 displays. The system is designed to refresh the display at a fixed refresh rate of 100 Hz. COLUMN ON time is optimized for each display length in order to maximize light output as shown in Figure 2.

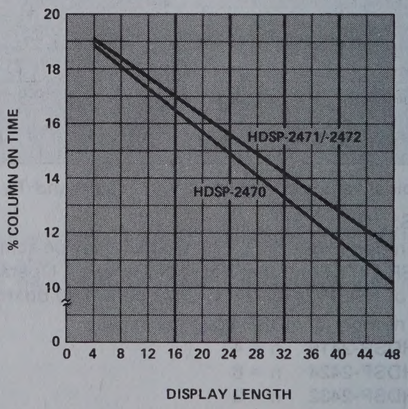


**Figure 2. Column on Time vs. Display Length for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**

**Control Mode/Data Entry**

User interface to the HDSP-247X Series controller is via an 8 bit word which provides to the controller either a control word or standard ASCII data input. In addition to this user provided 8 bit word, two additional control lines, CHIP SELECT and READY, allow easily generated "handshake" signals for interface purposes.

A logic low applied to the CHIP SELECT input (minimum six microseconds) causes the controller to read the 8 DATA IN lines and determine whether a control word or ASCII data word is present, as determined by the logic state of the most significant bit ($D_7$). If the controller detects a logic high at $D_7$, the state of $D_6$-$D_0$ will define the data entry mode and the number of alphanumeric characters to be displayed.

The 8 bit control data word format is outlined in Figure 3. For the control word ($D_7$ high), bits $D_6$ and $D_5$ define the selected data entry mode (Left entry, Right entry, etc.) and bits $D_3$ to $D_0$ define display length. Bit $D_4$ is ignored.

Control word inputs are first checked to verify that the control word is valid. The system ignores display lengths greater than 1011 for left block or right, or 0111 for RAM. If the word is valid, the present state—next state table shown in Figure 4 is utilized to determine whether or not to clear the display. For display lengths of up to 32 characters, RAM entry can be used as a powerful editing tool, or can be used to preload the cursor. With other transitions, the internal data memory is cleared.

CONTROL
WORD: $D_7D_6D_5D_4D_3D_2D_1D_0$

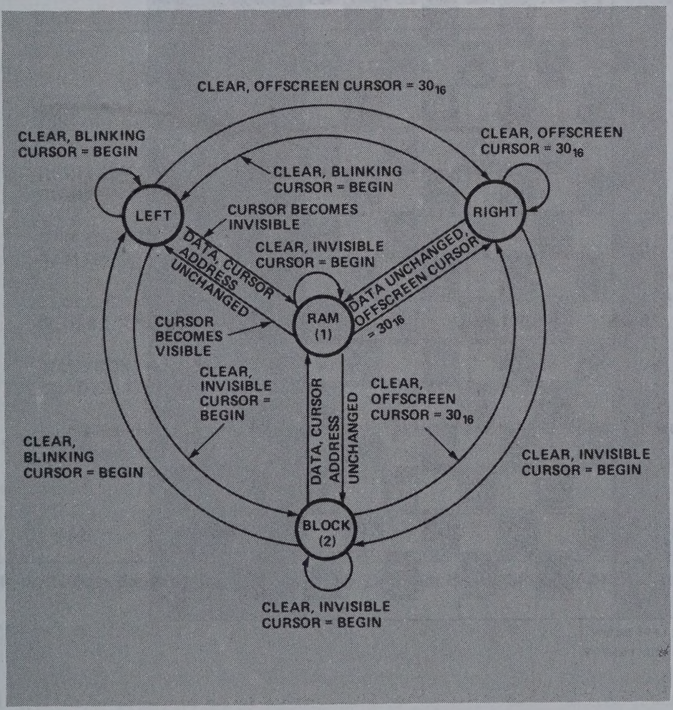
| 1 | X | X | – | Y | Y | Y | Y |
|---|---|---|---|---|---|---|---|

| Y Y Y Y | DISPLAY LENGTH: |
|---|---|
| 0 0 0 0 | 4 DIGITS |
| 0 0 0 1 | 8 " |
| 0 0 1 0 | 12 " |
| 0 0 1 1 | 16 " |
| 0 1 0 0 | 20 " |
| 0 1 0 1 | 24 " |
| 0 1 1 0 | 28 " |
| 0 1 1 1 | 32* " |
| 1 0 0 0 | 36 " |
| 1 0 0 1 | 40 " |
| 1 0 1 0 | 44 " |
| 1 0 1 1 | 48 " |

*maximum for RAM data entry mode

| X X | DATA ENTRY MODES |
|---|---|
| 0 0 | RAM DATA ENTRY |
| 0 1 | LEFT DATA ENTRY |
| 1 0 | RIGHT DATA ENTRY |
| 1 1 | BLOCK DATA ENTRY |

**Figure 3. Control Word Format for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**



CLEAR, OFFSCREEN CURSOR = $30_{16}$
CLEAR, BLINKING CURSOR = BEGIN
CLEAR, OFFSCREEN CURSOR = $30_{16}$
CLEAR, BLINKING CURSOR = BEGIN
LEFT
CURSOR BECOMES INVISIBLE
RIGHT
CLEAR, INVISIBLE CURSOR = BEGIN
DATA, CURSOR ADDRESS UNCHANGED
DATA UNCHANGED, OFFSCREEN CURSOR = $30_{16}$
RAM (1)
CURSOR BECOMES VISIBLE
CLEAR, INVISIBLE CURSOR = BEGIN
DATA, CURSOR ADDRESS UNCHANGED
CLEAR, OFFSCREEN CURSOR = $30_{16}$
CLEAR, BLINKING CURSOR = BEGIN
CLEAR, INVISIBLE CURSOR = BEGIN
BLOCK (2)
CLEAR, INVISIBLE CURSOR = BEGIN

(1) RAM ENTRY MODE IS VALID FOR DISPLAYS OF 32 CHARACTERS OR LESS IN LENGTH.

(2) FOLLOWING A TRANSITION FROM RAM TO BLOCK, WHEN THE CURSOR ADDRESS IS 48 ($30_{16}$) DURING THE TRANSITION, THE FIRST VALID ASCII CHARACTER WILL BE IGNORED AND THE SECOND VALID ASCII CHARACTER WILL BE LOADED IN THE LEFT-MOST DISPLAY LOCATION.

WHERE BEGIN IS DEFINED AS FOLLOWS:

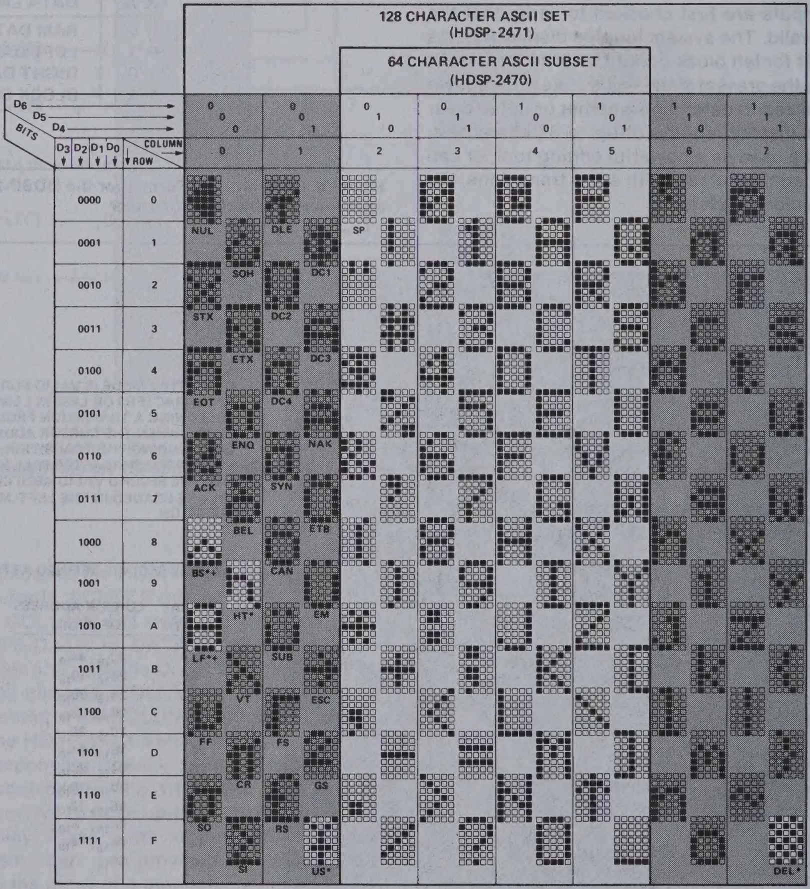
| DISPLAY LENGTH | CURSOR ADDRESS OF BEGIN |
|---|---|
| 4 | $2C_{16}$, $44_{10}$ |
| 8 | $28_{16}$, $40_{10}$ |
| 12 | $24_{16}$, $36_{10}$ |
| 16 | $20_{16}$, $32_{10}$ |
| 20 | $1C_{16}$, $28_{10}$ |
| 24 | $18_{16}$, $24_{10}$ |
| 28 | $14_{16}$, $20_{10}$ |
| 32 | $10_{16}$, $16_{10}$ |
| 36 | $0C_{16}$, $12_{10}$ |
| 40 | $08_{16}$, $8_{10}$ |
| 44 | $04_{16}$, $4_{10}$ |
| 48 | $00_{16}$ |

**Figure 4. Present State-Next State Diagram for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**

If D7 is a logic low when the DATA IN lines are read, the controller will interpret D6-D0 as standard ASCII data to be stored, decoded and displayed. The system accepts seven bit ASCII for all three versions. However, the HDSP-2470 system displays only the 64 character subset [$20_{16}$ (space) to $5F_{16}$ (_)] and ignores all ASCII characters outside this subset with the exception of those characters defined as display commands. These display commands are shown in Figure 5. Displayed character sets for the HDSP-2470/-2471 systems are shown in Figure 6.

| DATA WORD: | $D_7$ | $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ASCII ASSIGNMENT | 0 | A | A | A | A | A | A | A | DISPLAY COMMAND | | |
| LF | | 0 | 0 | 0 | 1 | 0 | 1 | 0 | CLEAR | Valid in Right Entry Mode | |
| BS | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | BACKSPACE CURSOR | | Valid in Left Entry Mode |
| HT | | 0 | 0 | 0 | 1 | 0 | 0 | 1 | FORWARDSPACE CURSOR | | |
| US | | 0 | 0 | 1 | 1 | 1 | 1 | 1 | INSERT CHARACTER | | |
| DEL | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | DELETE CHARACTER | | |

**Figure 5. Display Commands for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**


128 CHARACTER ASCII SET
(HDSP-2471)
64 CHARACTER ASCII SUBSET
(HDSP-2470)
BITS
D6
D5
D4
D3 D2 D1 D0
COLUMN
ROW
0 0 0
0 0 1
0 1 0
0 1 1
1 0 0
1 0 1
1 1 0
1 1 1
0 1 2 3 4 5 6 7
0000 0
0001 1
0010 2
0011 3
0100 4
0101 5
0110 6
0111 7
1000 8
1001 9
1010 A
1011 B
1100 C
1101 D
1110 E
1111 F
NUL
SOH
STX
ETX
EOT
ENQ
ACK
BEL
BS*+
HT*
LF*+
VT
FF
CR
SO
SI
DLE
DC1
DC2
DC3
DC4
NAK
SYN
ETB
CAN
EM
SUB
ESC
FS
GS
RS
US*
SP
DEL*

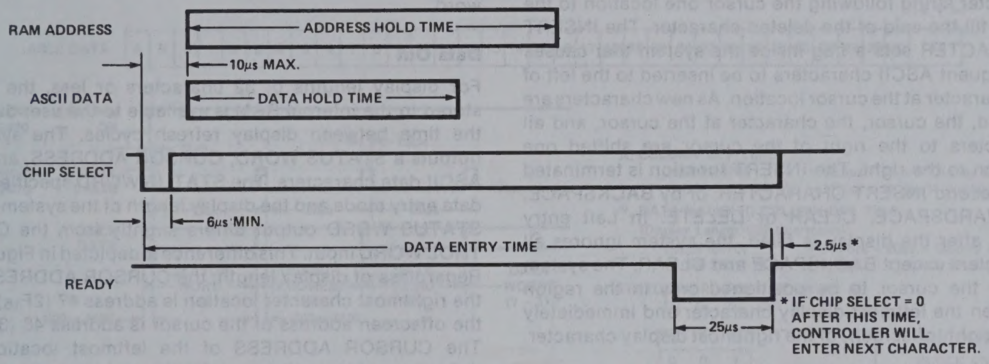
*DISPLAY COMMANDS WHEN USED IN LEFT ENTRY
+DISPLAY COMMANDS WHEN USED IN RIGHT ENTRY

**Figure 6. Display Font for the HDSP-2470 (64 Character ASCII Subset), and HDSP-2471 (128 Character ASCII Set) Alphanumeric Display Controller.**

Regardless of whether a control word or ASCII data word is presented by the user, a READY signal is generated by the controller after the input word is processed. This READY signal goes low for 25μs and upon a positive transition, a new CHIP SELECT may be accepted by the controller. Data Entry Timing is shown in Figure 7.

---

DATA ENTRY TIMING


RAM ADDRESS
ADDRESS HOLD TIME
10μs MAX.
ASCII DATA
DATA HOLD TIME
CHIP SELECT
6μs MIN.
DATA ENTRY TIME
2.5μs *
READY
25μs
* IF CHIP SELECT = 0
AFTER THIS TIME,
CONTROLLER WILL
ENTER NEXT CHARACTER.

MAXIMUM DATA ENTRY TIMES OVER OPERATING TEMPERATURE RANGE

| DATA ENTRY MODE |  | FUNCTION |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| HDSP- | DATA HOLD TIME* | DATA ENTRY | BACK SPACE | CLEAR | FORWARD SPACE | DELETE | INSERT |
| LEFT (2471/2) | 135μs | 235μs | 195μs | 505μs | 205μs | 725μs | 725μs |
| LEFT (2470) | 150μs | 245μs | 215μs | 530μs | 225μs | 745μs | 735μs |
| RIGHT (2471/2) | 85μs | 480μs | 470μs | 465μs |  |  |  |
| RIGHT (2470) | 105μs | 490μs | 490μs | 485μs |  |  |  |
| RAM (2471/2) | 55μs 120μs** | 190μs |  |  |  |  |  |
| RAM (2470) | 55μs 130μs** | 200μs |  |  |  |  |  |
| BLOCK (2471/2) | 55μs | 120μs | (155μs FOR RIGHTMOST CHARACTER) |  |  |  |  |
| BLOCK (2470) | 55μs | 130μs | (165μs FOR RIGHTMOST CHARACTER) |  |  |  |  |
| LOAD CONTROL (2471/2) | 50μs | 505μs |  |  |  |  |  |
| LOAD CONTROL (2470) | 50μs | 505μs |  |  |  |  |  |

*Minimum time that data inputs must remain valid after Chip Select goes low.
**Minimum time that RAM address inputs must remain valid after Chip Select goes low.

**Figure 7. Data Entry Timing and Data Entry Times for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**

### Left Entry Mode

With Left entry, characters are entered in typewriter fashion, i.e., to the right of all previous characters. Left entry uses a blinking cursor to indicate the location where the next character is to be entered. CLEAR loads the display with spaces and resets the cursor to the leftmost display location. BACKSPACE and FORWARDSPACE move the cursor without changing the character string. Thus, the user can backspace to the character to be edited, enter a character and then forward space the cursor. The DELETE function deletes the displayed character at the cursor location and then shifts the character string following the cursor one location to the left to fill the void of the deleted character. The INSERT CHARACTER sets a flag inside the system that causes subsequent ASCII characters to be inserted to the left of the character at the cursor location. As new characters are entered, the cursor, the character at the cursor, and all characters to the right of the cursor are shifted one location to the right. The INSERT function is terminated by a second INSERT CHARACTER, or by BACKSPACE, FORWARDSPACE, CLEAR or DELETE. In Left entry mode, after the display is filled, the system ignores all characters except BACKSPACE and CLEAR. The system allows the cursor to be positioned only in the region between the leftmost display character and immediately to the right (offscreen) of the rightmost display character.

### Right Entry Mode

In Right entry mode, characters are entered at the right hand side of the display and shifted to the left as new characters are entered. In this mode, the system stores 48 ASCII characters, although only the last characters entered are displayed. CLEAR loads the display with spaces. BACKSPACE shifts the display one location to the right, deleting the last character entered and displaying the next character in the 48 character buffer. Right entry mode is a simple means to implement the walking or "Times-Square" display. FORWARDSPACE, INSERT, and DELETE have character assignments in this mode since they are not treated as editing characters. In this mode, the cursor is located immediately to the right (offscreen) of the rightmost displayed character.

### Block Entry Mode

Block entry allows the fastest data entry rate of all four modes. In this mode, characters are loaded from left to right as with Left entry. However, with Block entry, after the display is completely loaded, the next ASCII character is loaded in the leftmost display location, replacing the previous displayed character. While Block entry has a nonvisible cursor, the cursor is always loaded with the address of the next character to be entered. In this entry mode, the system can display the complete 128 character ASCII set. The display can be cleared and the cursor reset to the leftmost display location by loading in a new BLOCK control word.

### RAM Entry Mode

In RAM entry, ASCII characters are loaded at the address specified by the five bit RAM address. Due to the limitation of only five address lines, RAM data entry is allowed only for displays less than or equal to 32 characters. Regardless of display length, address 00 is the leftmost display character. Out of range RAM addresses are ignored. While RAM entry has a non-visible cursor, the cursor is always preloaded with the address to the right of the last character entered. This allows the cursor to be preloaded with an address prior to going into any other entry mode. In RAM entry, the system can display the complete 128 character ASCII set because it does not interpret any of the characters as control functions. The display can be cleared by loading in a new RAM control word.

### Data Out

For display lengths of 32 characters or less, the data stored in the internal RAM is available to the user during the time between display refresh cycles. The system outputs a STATUS WORD, CURSOR ADDRESS, and 32 ASCII data characters. The STATUS WORD specifies the data entry mode and the display length of the system. The STATUS WORD output differs slightly from the CONTROL WORD input. This difference is depicted in Figure 8. Regardless of display length, the CURSOR ADDRESS of the rightmost character location is address 47 ($2F_{16}$) and the offscreen address of the cursor is address 48 ($30_{16}$). The CURSOR ADDRESS of the leftmost location is defined as address 48 minus the display length. A general formula for CURSOR ADDRESS is:

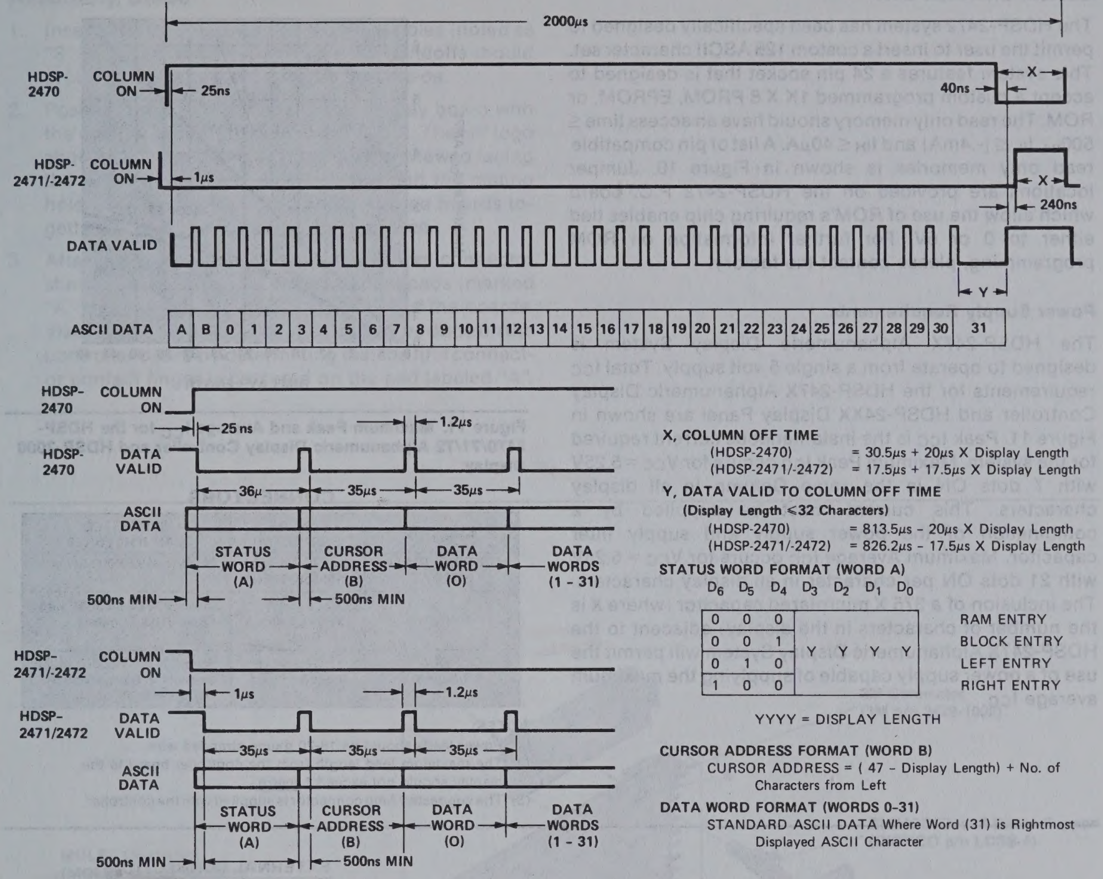
CURSOR ADDRESS =

(47 - Display Length) + Number of Characters from Left.

For example, suppose the alphanumeric display is 16 characters long and the cursor was blinking at the third digit from the left. Then the CURSOR ADDRESS would be 47 - 16 + 3 or 34 ($22_{16}$) and the 18th ASCII data word would correspond to the ASCII character at the location of the display cursor. In Left and Block entry, the CURSOR ADDRESS specifies the location where the next ASCII data character is to be entered. In RAM entry, the CURSOR ADDRESS specifies the location to the right of the last character entered. In Right entry, the CURSOR ADDRESS is always 48 ($30_{16}$). The negative edge of the DATA VALID output can be used to load the 34 DATA OUT words into the user's system. The DATA OUT timing for the HDSP-247X systems are summarized in Figure 8. For displays longer than 32 characters, the system only outputs the STATUS WORD between refresh cycles.

### Master/Power On Reset

When power is first applied to the system, the system clears the display and tests the state of the DATA INPUT, $D_7$. If $D_7 > 2.0V$, the systems loads the control word on the DATA INPUTS into the system. If $D_7 \leq .8V$ or the system sees an invalid control word, the system initializes as Left entry for a 32 character display with a flashing cursor in the leftmost location. For POWER ON RESET to function properly, the power supply must turn on at a rate > 100 V/s. In addition, the system can be reset by pulling the RESET input low for a minimum of 50 milliseconds. POWER ON/MASTER RESET timing is shown in Figure 9.


2000μs
HDSP-2470 COLUMN ON
25ns
40ns
X
HDSP-2471/-2472 COLUMN ON
1μs
X
240ns
DATA VALID
Y
ASCII DATA
A B 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
HDSP-2470 COLUMN ON
25 ns
1.2μs
HDSP-2470 DATA VALID
36μ
35μs
35μs
ASCII DATA
STATUS WORD (A)
CURSOR ADDRESS (B)
DATA WORD (O)
DATA WORDS (1 - 31)
500ns MIN
500ns MIN
HDSP-2471/-2472 COLUMN ON
1μs
1.2μs
HDSP-2471/2472 DATA VALID
35μs
35μs
35μs
ASCII DATA
STATUS WORD (A)
CURSOR ADDRESS (B)
DATA WORD (O)
DATA WORDS (1 - 31)
500ns MIN
500ns MIN

**X, COLUMN OFF TIME**
(HDSP-2470) = 30.5μs + 20μs X Display Length
(HDSP-2471/-2472) = 17.5μs + 17.5μs X Display Length

**Y, DATA VALID TO COLUMN OFF TIME**
**(Display Length <32 Characters)**
(HDSP-2470) = 813.5μs - 20μs X Display Length
(HDSP-2471/-2472) = 826.2μs - 17.5μs X Display Length

**STATUS WORD FORMAT (WORD A)**

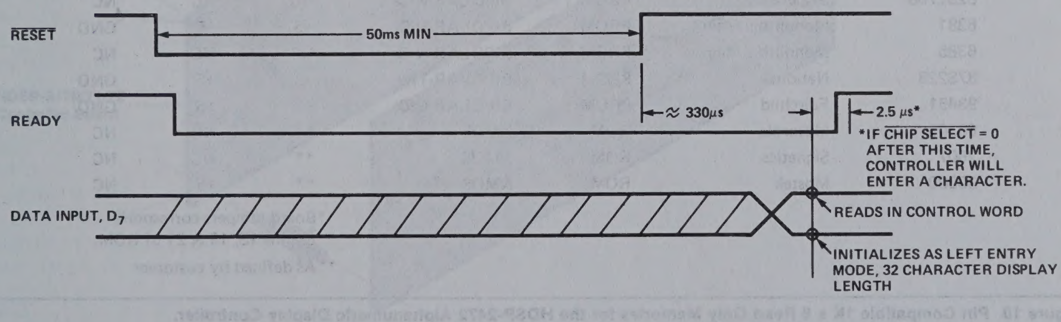
| $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ | |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | Y | Y | Y | Y | RAM ENTRY |
| 0 | 0 | 1 | | | | | BLOCK ENTRY |
| 0 | 1 | 0 | | | | | LEFT ENTRY |
| 1 | 0 | 0 | | | | | RIGHT ENTRY |

YYYY = DISPLAY LENGTH

**CURSOR ADDRESS FORMAT (WORD B)**
CURSOR ADDRESS = ( 47 - Display Length) + No. of Characters from Left

**DATA WORD FORMAT (WORDS 0-31)**
STANDARD ASCII DATA Where Word (31) is Rightmost Displayed ASCII Character

**Figure 8. Data Out Timing and Format for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**


RESET
50ms MIN
READY
≈ 330μs
2.5 μs*
DATA INPUT, D7
READS IN CONTROL WORD
INITIALIZES AS LEFT ENTRY MODE, 32 CHARACTER DISPLAY LENGTH

*IF CHIP SELECT = 0 AFTER THIS TIME, CONTROLLER WILL ENTER A CHARACTER.

**Figure 9. Power-On/Master Reset Timing for the HDSP-2470/-2471/-2472 Alphanumeric Display Controller.**

### Custom Character Sets

The HDSP-2472 system has been specifically designed to permit the user to insert a custom 128 ASCII character set. This system features a 24 pin socket that is designed to accept a custom programmed 1K X 8 PROM, EPROM, or ROM. The read only memory should have an access time ≤ 500ns, $I_{IL} \leq |-.4mA|$ and $I_{IH} \leq 40\mu A$. A list of pin compatible read only memories is shown in Figure 10. Jumper locations are provided on the HDSP-2472 P.C. board which allow the use of ROM's requiring chip enables tied either to 0 or 5V. For further information on ROM programming, please contact the factory.

### Power Supply Requirements

The HDSP-247X Alphanumeric Display System is designed to operate from a single 5 volt supply. Total $I_{CC}$ requirements for the HDSP-247X Alphanumeric Display Controller and HDSP-24XX Display Panel are shown in Figure 11. Peak $I_{CC}$ is the instantaneous current required for the system. Maximum Peak $I_{CC}$ occurs for $V_{CC} = 5.25V$ with 7 dots ON in the same Column in all display characters. This current must be supplied by a combination of the power supply and supply filter capacitor. Maximum Average $I_{CC}$ occurs for $V_{CC} = 5.25V$ with 21 dots ON per character in all display characters. The inclusion of a 375 X microfarad capacitor (where X is the number of characters in the display) adjacent to the HDSP-247X Alphanumeric Display System will permit the use of a power supply capable of supplying the maximum average $I_{CC}$.

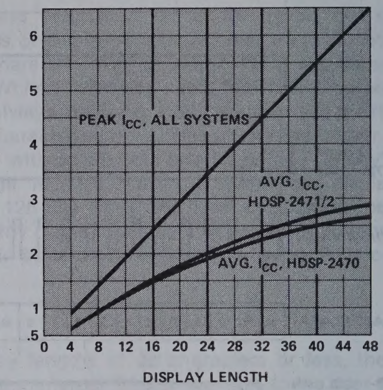


**Figure 11. Maximum Peak and Average $I_{CC}$ for the HDSP-2470/71/72 Alphanumeric Display Controller and HDSP-2000 Display.**

### CONNECTORS

| FUNCTION | TYPE OF CONNECTOR | SUGGESTED MANUFACTURER |
|---|---|---|
| CONTROL/DATA ENTRY | 26 Pin Ribbon Cable | 3M P/N 3399-X000 Series |
| POWER(1) | 3 Pin With Locking Ramp | Molex P/N 09-50-3031 with 08-50-0106 Terminals |
| DISPLAY DRIVE(2,3) | 17 Lead Board to Board | Amp P/N 1-530500-7, also available in board to cable and other configurations |

NOTES:
(1) Power leads should be 18-20 gauge stranded wire.
(2) The maximum lead length from the controller board to the display should not exceed 1 metre.
(3) The suggested Amp connector is supplied with the controller.

| | | | | EXTERNAL CONNECTION* | | |
|---|---|---|---|---|---|---|
| PART NUMBER | MANUFACTURER | TYPE | CONSTRUCTION | X | Y | Z |
| 2758 | Intel | EPROM | NMOS | GND | GND | +5 |
| 7608 | Harris | PROM | BIPOLAR-NiCr | NC | NC | NC |
| 3628-4 | Intel | PROM | BIPOLAR-Si | +5 | +5 | GND |
| 82S2708 | Signetics | PROM | BIPOLAR-NiCr | NC | NC | NC |
| 6381 | Monolithic Mem. | PROM | BIPOLAR-NiCr | +5 | +5 | GND |
| 6385 | Monolithic Mem. | PROM | BIPOLAR-NiCr | NC | NC | NC |
| 87S228 | National | PROM | BIPOLAR-TiW | +5 | +5 | GND |
| 93451 | Fairchild | PROM | BIPOLAR-NiCr | +5 | +5 | GND |
| 68308 | Motorola | ROM | NMOS | ** | NC | NC |
| 2607 | Signetics | ROM | NMOS | ** | NC | NC |
| 30000 | Mostek | ROM | NMOS | ** | +5 | NC |

*Board jumpers correspond to pins 18, 19 & 21 of ROM.
**As defined by customer

**Figure 10. Pin Compatible 1K x 8 Read Only Memories for the HDSP-2472 Alphanumeric Display Controller.**

## Display Boards/Hardware

The mechanical layout of the HDSP-247X Series allows direct mating of the controller P.C. board to a compatible series of display boards available from Hewlett-Packard. These display boards consist of matched and tested HDSP-2000 clusters soldered to a P.C. board.

Included with the controller board are: 1 each Amp P/N 1-530500-7 board to board connector, and 4 each locking circuit board support nylon standoffs (Richco LCBS-4). This hardware allows the controller board to interconnect with any of the standard display boards. Figure 12 depicts correct assembly technique.

## Assembly Steps

1. Insert the standoffs into .151 diameter holes (noted as "S" on Figure 12. The long end of the standoffs should protrude through the controller board side.
2. Position the controller board and display board with the components and displays facing out. The HP logo should be in the upper left corner when viewed facing the boards. Insert the standoffs through the mating holes on the display board and press the boards together so that the standoffs lock in place.
3. After the standoffs are secured, the Amp connector should be placed on the edge connect pads (marked "A" through "Q" Figure 12) at the top of the boards. Visual alignment of this connector may be done on the controller board by determining that the first connector contact finger is centered on the pad labeled "A".

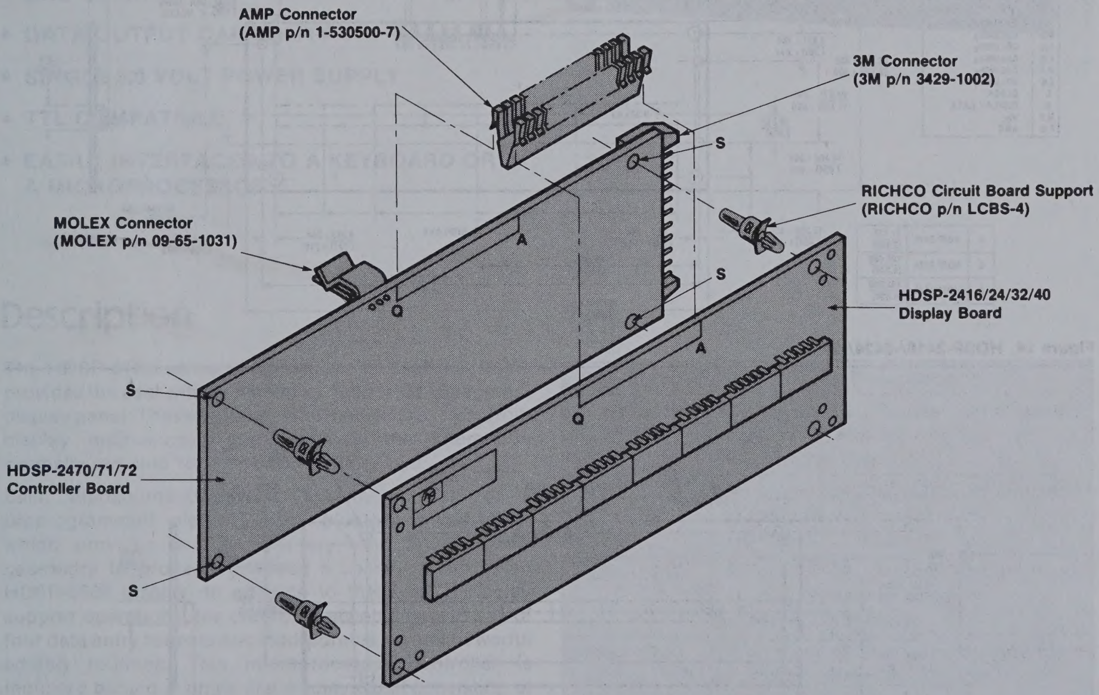

AMP Connector
(AMP p/n 1-530500-7)
3M Connector
(3M p/n 3429-1002)
S
RICHCO Circuit Board Support
(RICHCO p/n LCBS-4)
MOLEX Connector
(MOLEX p/n 09-65-1031)
A
S
Q
HDSP-2416/24/32/40
Display Board
A
S
Q
HDSP-2470/71/72
Controller Board
S

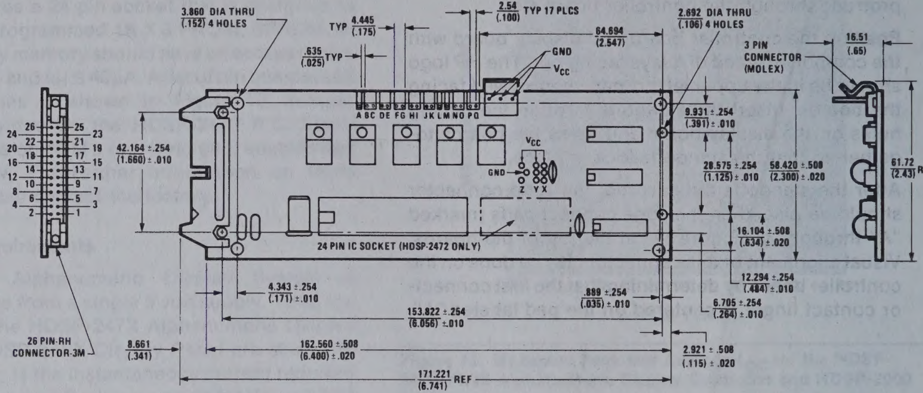
Figure 12. Assembly Drawing.

# Package Dimensions

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN mm AND (INCHES)

HDSP-2470/-2471/-2472

| PIN | DESCRIPTION |
|---|---|
| 1 | $\overline{\text{CHIP SELECT}}$ |
| 2 | DATA VALID |
| 3 | RAM ADDRESS, $A_0$ |
| 4 | DATA IN, $D_7$ |
| 5 | RAM ADDRESS, $A_1$ |
| 6 | $\overline{\text{RESET}}$ |
| 7 | RAM ADDRESS, $A_2$ |
| 8 | DATA OUT, $DO_6$ |
| 9 | RAM ADDRESS, $A_3$ |
| 10 | DATA OUT, $DO_5$ |
| 11 | DATA IN, $D_0$ |
| 12 | DATA OUT' $DO_4$ |
| 13 | DATA IN, $D_1$ |
| 14 | DATA OUT, $DO_3$ |
| 15 | DATA IN, $D_2$ |
| 16 | DATA OUT, $DO_2$ |
| 17 | DATA IN, $D_3$ |
| 18 | DATA OUT, $DO_1$ |
| 19 | DATA IN, $D_4$ |
| 20 | DATA OUT, $DO_0$ |
| 21 | DATA IN, $D_5$ |
| 22 | READY |
| 23 | DATA IN, $D_6$ |
| 24 | COLUMN ON |
| 25 | RAM ADDRESS, $A_4$ |
| 26 | DISPLAY BLANK, $V_B$ |

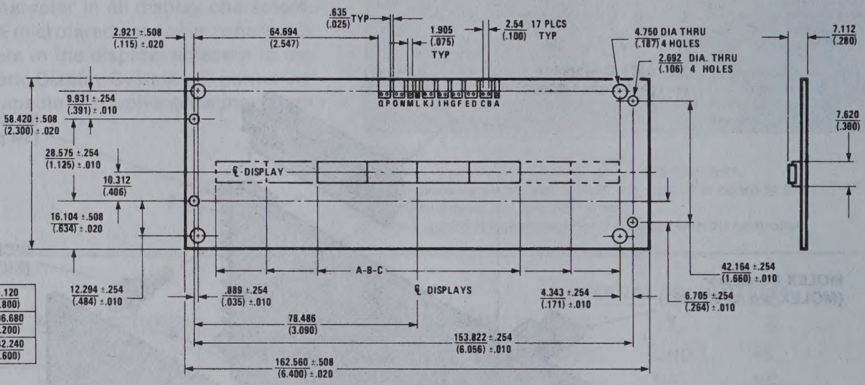


26 24 22 20 18 16 14 12 10 8 6 4 2
25 23 21 19 17 15 13 11 9 7 5 3 1
26 PIN-RH CONNECTOR-3M
3.860 DIA THRU (.152) 4 HOLES
4.445 (.175) TYP
.635 (.025) TYP
2.54 (.100) TYP 17 PLCS
64.694 (2.547)
GND
$V_{CC}$
A B C DE FG HI JK LM NO PQ
$V_{CC}$
GND
Z Y X
2.692 DIA THRU (.106) 4 HOLES
3 PIN CONNECTOR (MOLEX)
16.51 (.65)
9.931 ±.254 (.391) ±.010
28.575 ±.254 (1.125) ±.010
58.420 ±.508 (2.300) ±.020
61.72 (2.43) REF
16.104 ±.508 (.634) ±.020
12.294 ±.254 (.484) ±.010
6.705 ±.254 (.264) ±.010
42.164 ±.254 (1.660) ±.010
24 PIN IC SOCKET (HDSP-2472 ONLY)
4.343 ±.254 (.171) ±.010
.889 ±.254 (.035) ±.010
153.822 ±.254 (6.056) ±.010
8.661 (.341)
162.560 ±.508 (6.400) ±.020
2.921 ± .508 (.115) ± .020
171.221 (6.741) REF

Figure 13. HDSP-2470/-2471/-2472

HDSP-2416/-2424/-2432/-2440
HDSP-2470/-2471/-2472

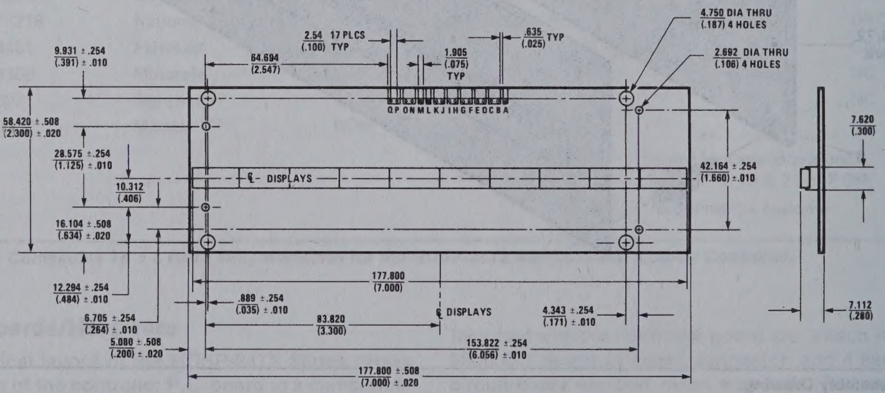
| PIN | DESCRIPTION |
|---|---|
| A | DISPLAY BLANK, $V_B$ |
| B,C | $COLUMN_1$ |
| D,E | $COLUMN_2$ |
| F,G | $COLUMN_3$ |
| H,I | $COLUMN_4$ |
| J,K | $COLUMN_5$ |
| L | CLOCK |
| M | DISPLAY DATA |
| N,O | $V_{CC}$ |
| P,Q | GND |



.635 (.025) TYP
2.921 ±.508 (.115) ±.020
64.694 (2.547)
1.905 (.075) TYP
2.54 (.100) 17 PLCS TYP
4.750 DIA THRU (.187) 4 HOLES
2.692 DIA. THRU (.106) 4 HOLES
7.112 (.280)
Q P O N M L K J I H G F E D C B A
9.931 ±.254 (.391) ±.010
58.420 ±.508 (2.300) ±.020
28.575 ±.254 (1.125) ±.010
℄ DISPLAY
10.312 (.406)
7.620 (.300)
16.104 ±.508 (.634) ±.020
A-B-C
42.164 ±.254 (1.660) ±.010
12.294 ±.254 (.484) ±.010
.889 ±.254 (.035) ±.010
℄ DISPLAYS
4.343 ±.254 (.171) ±.010
6.705 ±.254 (.264) ±.010
78.486 (3.090)
153.822 ±.254 (6.056) ±.010
162.560 ±.508 (6.400) ±.020

|  |  |  |
|---|---|---|
| A | HDSP-2416 | 71.120<br>(2.800) |
| B | HDSP-2424 | 106.680<br>(4.200) |
| C | HDSP-2432 | 142.240<br>(5.600) |

Figure 14. HDSP-2416/-2424/-2432



4.750 DIA THRU (.187) 4 HOLES
2.54 17 PLCS (.100) TYP
.635 (.025) TYP
9.931 ± .254 (.391) ± .010
64.694 (2.547)
1.905 (.075) TYP
2.692 DIA THRU (.106) 4 HOLES
Q P O N M L K J I H G F E D C B A
7.620 (.300)
58.420 ± .508 (2.300) ± .020
28.575 ± .254 (1.125) ± .010
10.312 (.406)
℄ DISPLAYS
42.164 ± .254 (1.660) ± .010
16.104 ± .508 (.634) ± .020
177.800 (7.000)
12.294 ± .254 (.484) ± .010
.889 ± .254 (.035) ± .010
℄ DISPLAYS
4.343 ± .254 (.171) ± .010
7.112 (.280)
6.705 ± .254 (.264) ± .010
83.820 (3.300)
5.080 ± .508 (.200) ± .020
153.822 ± .254 (6.056) ± .010
177.800 ± .508 (7.000) ± .020

Figure 15. HDSP-2440

**HEWLETT PACKARD**

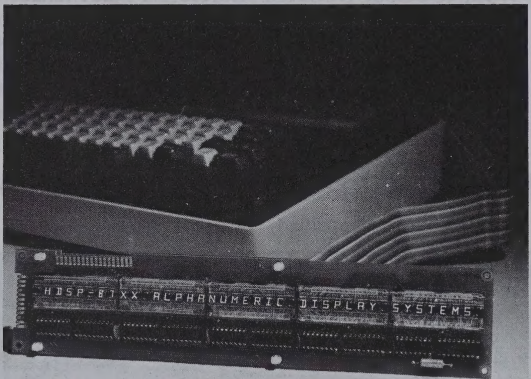
# 16 SEGMENT ALPHANUMERIC DISPLAY SYSTEM

**HDSP-8716**
**HDSP-8724**
**HDSP-8732**
**HDSP-8740**

TECHNICAL DATA FEBRUARY 1982

## Features

- **COMPLETE ALPHANUMERIC DISPLAY SYSTEM UTILIZING THE HDSP-6508 DISPLAY**
- **DISPLAYS 64 CHARACTER ASCII SET**
- **CHOICE OF 16, 24, 32, OR 40 ELEMENT DISPLAY PANEL**
- **MULTIPLE DATA ENTRY FORMATS Left, Right, RAM, or Block Entry**
- **EDITING FEATURES THAT INCLUDE CURSOR, BACKSPACE, FORWARDSPACE, INSERT, DELETE, CARRIAGE RETURN, AND CLEAR**
- **DATA OUTPUT CAPABILITY**
- **SINGLE 5.0 VOLT POWER SUPPLY**
- **TTL COMPATIBLE**
- **EASILY INTERFACED TO A KEYBOARD OR A MICROPROCESSOR**



## Description

The HDSP-87XX series of alphanumeric display systems provides the user with a completely supported 16 segment display panel. These products free the user's system from display maintenance and minimize the interaction normally required for alphanumeric displays.

Each alphanumeric display system consists of a preprogrammed microprocessor plus associated logic, which provides decode, memory, and drive signals necessary to properly interface a user's system to an HDSP-6508 display. In addition to these basic display support operations, the controller accepts data in any of four data entry formats and incorporates several powerful editing routines. This microprocessor controller is mounted behind a single line display panel consisting of HDSP-6508 displays matched for luminous intensity.

These alphanumeric display systems are attractive for applications such as data entry terminals, instrumentation,, electronic typewriters, and other products which require an easy to use 16 segment alphanumeric display system.

| Part Number | Description |
|---|---|
| HDSP-8716 | Single-line 16 Character Alphanumeric Display System utilizing the HDSP-6508 Display |
| HDSP-8724 | Single-line 24 Character Alphanumeric Display System utilizing the HDSP-6508 Display |
| HDSP-8732 | Single-line 32 Character Alphanumeric Display System utilizing the HDSP-6508 Display |
| HDSP-8740 | Single-line 40 Character Alphanumeric Display System utilizing the HDSP-6508 Display |

# HDSP-8716/-8724/-8732/-8740

## Absolute Maximum Ratings

$V_{CC}$ .................................... -0.5V to 6.0V

Operating Temperature Range,
Ambient ($T_A$) .......................... 0°C to 70°C

Storage Temperature Range ($T_S$) ...... -40°C to 85°C

Voltage Applied to any
Input or Output ...................... -0.5V to 6.0V

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.75 | 5.25 | V |
| Data Out, Data Valid Ready, Refresh | $I_{OL}$ | | 3.2 | mA |
| | $I_{OH}$ | | -80 | µA |
| Active, Clock | $I_{OL}$ | | 1.6 | mA |
| | $I_{OH}$ | | -40 | µA |

## Electrical Characteristics Over Operating Temperature Range

(Unless otherwise specified)

| Parameter | | Symbol | Min. | Typ.[5] | Max. | Units | Conditions |
|---|---|---|---|---|---|---|---|
| Supply Current | HDSP-8716/-8724 | $I_{CC}$ | | 560 | 1150 | mA | $V_{CC}$=5.25V, "$" Displayed in All Character Locations, All Outputs Open |
| | HDSP-8732/-8740 | $I_{CC}$ | | 700 | 1320 | mA | |
| Time Average Luminous Intensity Per Digit, 10 Segments on[1] | | $I_V$ | .24 | .70 | | mcd | $V_{CC}$=5.0V, Digit Average '$' Displayed In All Character Locations, $T_A$=25°C |
| Input Threshold High (except Reset) | | $V_{IH}$ | 2.0 | | | V | $V_{CC}$=5.0V ± .25V |
| Input Threshold High — Reset[2] | | $V_{IH}$ | 3.0 | | | V | |
| Input Threshold Low — All Inputs | | $V_{IL}$ | | | 0.8 | V | |
| Data Out, Data Valid, Ready, Refresh, Output Voltage | | $V_{OH}$ | 2.4 | | | V | $I_{OH}$=-80µA, $V_{CC}$ = 4.75V |
| | | $V_{OL}$ | | | 0.5 | V | $I_{OL}$=3.2 mA, $V_{CC}$=4.75V |
| Active, Clock Output Voltage | | $V_{OH}$ | 2.4 | | | V | $I_{OH}$=-40µA, $V_{CC}$=4.75V |
| | | $V_{OL}$ | | | 0.5 | V | $I_{OL}$=1.6mA, $V_{CC}$=4.75V |
| Address,[3] Expand, Input Current | | $I_{IH}$ | | | -0.3 | mA | $V_{IH}$=2.4V, $V_{CC}$=5.25V |
| | | $I_{IL}$ | | | -0.6 | mA | $V_{IL}$=0.5V, $V_{CC}$=5.25V |
| Blank Input Current | | $I_{IH}$ | | | -0.5 | mA | $V_{IH}$=2.4V, $V_{CC}$=5.25V |
| | | $I_{IL}$ | | | -1.0 | mA | $V_{IL}$=0.5V, $V_{CC}$=5.25V |
| Reset Input Current | | $I_{IH}$ | | | -0.5 | mA | $V_{IH}$=3.0V, $V_{CC}$=5.25V |
| | | $I_{IL}$ | | | -1.0 | mA | $V_{IL}$=0.5V, $V_{CC}$=5.25V |
| Data In, Chip Select, Input Current | | $I_I$ | -10 | | +10 | µA | $0<V_I<V_{CC}$ |
| Peak Wavelength | | $\lambda_{PEAK}$ | | 655 | | nm | |
| Dominant Wavelength[4] | | $\lambda_d$ | | 640 | | nm | |

NOTES:

1. The luminous intensity ratio between segments within a digit is designed so that each segment will have the same luminous sterance. Thus, each segment will appear with equal brightness to the eye.
2. External reset may be initiated by grounding Reset with either a switch or open collector TTL gate for a minimum time of 50ms. For Power On Reset to function properly, $V_{CC}$ power supply should turn on at a rate > 100V/S.
3. Momentary peak surge currents may exist on these lines. However, these momentary currents will not interfere with proper operation of the HDSP-8716/-8724/-8732/-8740.
4. The dominant wavelength, $\lambda_d$, is derived from the C.I.E. chromaticity diagram and represents that single wavelength which defines the color of the device, standard red.
5. All typical values at $V_{CC}$ = 5.0V and $T_A$ = 25°C unless otherwise noted.

## System Overview

The HDSP-8716/-8724/-8732/-8740 Alphanumeric Display Controllers provide the interface between any ASCII based Alphanumeric System and the HDSP-6508 Alphanumeric Display. ASCII data is loaded into the system by means of any one of four data entry modes — Left, Right, RAM, or Block Entry. This ASCII data is stored in the internal RAM memory of the system. The system may also be expanded to form multiple line panels with system to system control signals.

The user interfaces to any of the system through eight DATA IN inputs, six ADDRESS inputs (RAM mode), a CHIP SELECT input, RESET input, BLANK input, EXPAND input, six DATA OUT outputs, a READY output, DATA VALID output, REFRESH output, and CLOCK output. A low level on the RESET input clears the display and initializes the system. A low level on the CHIP SELECT input causes the system to load data from the DATA IN and ADDRESS inputs into the system. A special control word causes the controller to output a STATUS WORD, CURSOR ADDRESS, and a string of ASCII characters through the DATA OUT outputs and DATA VALID output. A low level on the EXPAND input allows two or more systems to be configured for multiple line display panels. Pulse width modulation of display luminous intensity can be provided by connecting REFRESH to the input of a monostable multivibrator and the output of the monostable multivibrator to the BLANK input. A 400kHz clock is provided on the CLOCK output. A system block diagram for the HDSP-8716/-8724/-8732/-8740 systems is shown in Figure 1. The system is designed to refresh the display at a fixed refresh rate of 100Hz. The display duty factor is optimized for each display length in order to maximize light output.

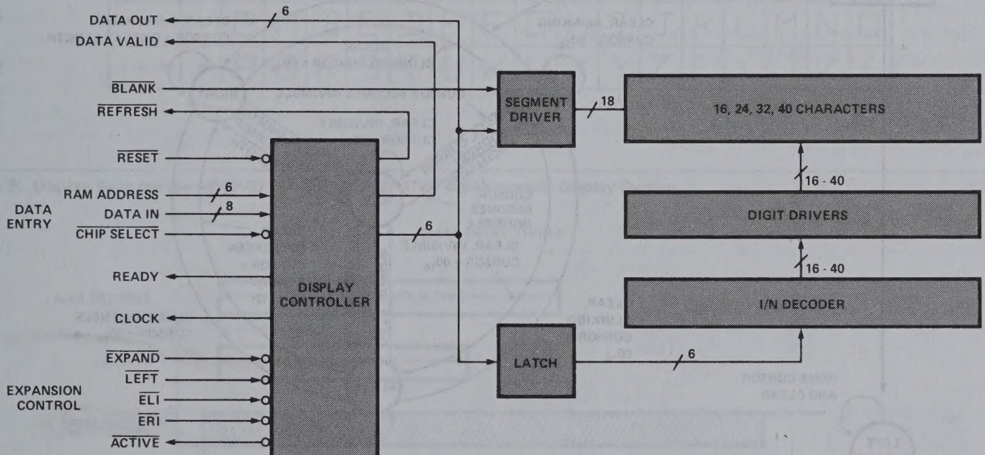


Figure 1. Block Diagram of the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.

## Control Mode/Data Entry

User interface to the HDSP-87XX series controller is via an 8-bit word which provides to the controller either a control word or standard ASCII data input. In addition to this user provided 8-bit word, two additional control lines, CHIP SELECT and READY, allow easily generated "handshake" signals for interface purposes.

A logic low applied to the CHIP SELECT input (minimum six microseconds) causes the controller to read the 8 DATA IN lines and determine whether a control word or ASCII data word is present, as determined by the logic state of the most significant bit ($D_7$). If the controller detects a logic high at $D_7$, the state of $D_6$-$D_0$ will define the data entry mode and appropriate display length.

The 8 bit control data word format is outlined in Figure 2. For the control word ($D_7$ high), bits $D_5$ and $D_4$ define the selected data entry mode (Left entry, Right entry, etc.) and bits $D_3$ to $D_0$ define display length. Bit $D_6$ is ignored.

Control word inputs are first checked to verify that the control word is valid. If the word is valid, the present state — next state table shown in Figure 3 is utilized to determine whether or not to clear the display. RAM entry can be used as a powerful editing tool or can be used to preload the cursor. With other transitions, the internal memory is cleared. The CONTROL WORD $1XXX11XX_2$ is used by the controller to initiate the DATA OUT function.

DATA ENTRY CONTROL WORD: $D_7\,D_6\,D_5\,D_4\,D_3\,D_2\,D_1\,D_0$

| 1 | – | X | X | Y | Y | Y | Y |
|---|---|---|---|---|---|---|---|

| X | X | DATA ENTRY MODES |
|---|---|---|
| 0 | 0 | RAM DATA ENTRY |
| 0 | 1 | LEFT DATA ENTRY |
| 1 | 0 | RIGHT DATA ENTRY |
| 1 | 1 | BLOCK DATA ENTRY |

| Y | Y | Y | Y | DISPLAY LENGTH | |
|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 16 DIGITS | HDSP-8716 |
| 0 | 1 | 0 | 1 | 24 DIGITS | HDSP-8724 |
| 0 | 1 | 1 | 1 | 32 DIGITS | HDSP-8732 |
| 1 | 0 | 0 | 1 | 40 DIGITS | HDSP-8740 |

DATA OUT CONTROL WORD: $D_7\,D_6\,D_5\,D_4\,D_3\,D_2\,D_1\,D_0$

| 1 | – | – | – | 1 | 1 | – | – | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | DATA OUT |

Figure 2. Control Word Format for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.

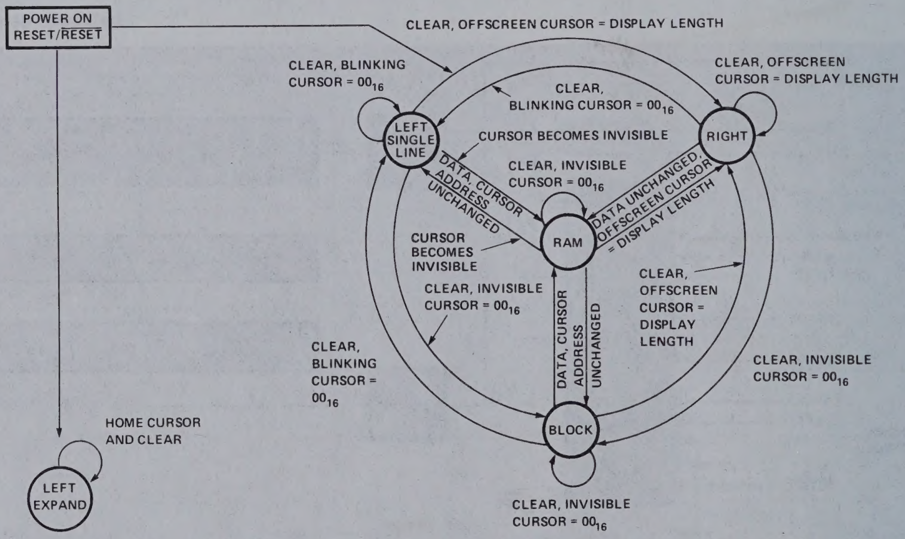

POWER ON
RESET/$\overline{\text{RESET}}$
CLEAR, OFFSCREEN CURSOR = DISPLAY LENGTH
CLEAR, BLINKING CURSOR = $00_{16}$
CLEAR, BLINKING CURSOR = $00_{16}$
CLEAR, OFFSCREEN CURSOR = DISPLAY LENGTH
LEFT SINGLE LINE
RIGHT
CURSOR BECOMES INVISIBLE
CLEAR, INVISIBLE CURSOR = $00_{16}$
DATA, CURSOR ADDRESS UNCHANGED
DATA UNCHANGED, OFFSCREEN CURSOR = DISPLAY LENGTH
RAM
CURSOR BECOMES INVISIBLE
CLEAR, INVISIBLE CURSOR = $00_{16}$
CLEAR, OFFSCREEN CURSOR = DISPLAY LENGTH
CLEAR, BLINKING CURSOR = $00_{16}$
DATA, CURSOR ADDRESS UNCHANGED
CLEAR, INVISIBLE CURSOR = $00_{16}$
HOME CURSOR AND CLEAR
BLOCK
LEFT EXPAND
CLEAR, INVISIBLE CURSOR = $00_{16}$

Figure 3. Present State-Next State Diagram for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.

DATA WORD: $D_7\,D_6\,D_5\,D_4\,D_3\,D_2\,D_1\,D_0$

ASCII ASSIGNMENT

| 0 | X | X | X | X | X | X | X |
|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| BS | 0 | 0 | 0 | 1 | 0 | 0 | 0 | BACKSPACE | RIGHT | LEFT, SINGLE | LEFT, EXPAND* |
| LF | 0 | 0 | 0 | 1 | 0 | 1 | 0 | CLEAR (NEW LINE*) | | | |
| HT | 0 | 0 | 0 | 1 | 0 | 0 | 1 | FORWARDSPACE | | | |
| CR | 0 | 0 | 0 | 1 | 1 | 0 | 1 | CARRIAGE RETURN | | | |
| US | 0 | 0 | 1 | 1 | 1 | 1 | 1 | INSERT CHARACTER | | | |
| DEL | 1 | 1 | 1 | 1 | 1 | 1 | 1 | DELETE CHARACTER | | | |
| VT | 0 | 0 | 0 | 1 | 0 | 1 | 1 | CURSOR DOWN | | | |
| FF | 0 | 0 | 0 | 1 | 1 | 0 | 0 | HOME & CLEAR | | | |
| RS | 0 | 0 | 1 | 1 | 1 | 1 | 0 | CURSOR UP | | | |

OTHERWISE, THE 7 BIT ASCII CODE

Figure 4. Display Commands for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.

If $D_7$ is a logic low when the DATA IN lines are read, the controller will interpret $D_6$-$D_0$ as standard ASCII data to be stored, decoded, and displayed. The system accepts the standard 7-bit ASCII code. However, the HDSP-87XX system displays only the 64 character subset |$20_{16}$ (space) to $5F_{16}$ (↑)| and ignores all ASCII characters outside this subset with the exception of those characters defined as display commands. These display commands are shown in Figure 4. The displayed character set for the HDSP-87XX system is shown in Figure 5.

Regardless of whether a control word or ASCII data word is presented by the user, a READY signal is generated by the controller after the input word is processed. This READY signal goes low for 35μs and upon a positive transition, a new $\overline{\text{CHIP SELECT}}$ may be accepted by the controller. Data Entry Timing is shown in Figure 6.

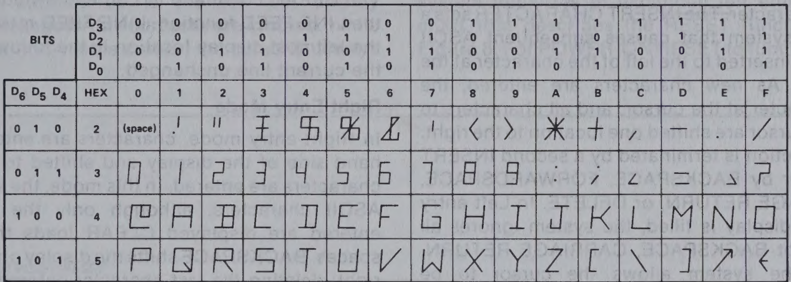
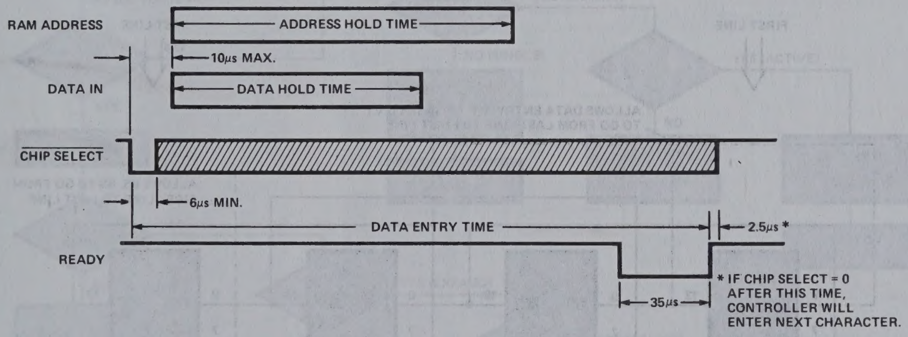

BITS
D3
D2
D1
D0
D6 D5 D4
HEX
0
1
2
3
4
5
6
7
8
9
A
B
C
D
E
F
0 1 0
2
(space)
0 1 1
3
1 0 0
4
1 0 1
5

**Figure 5. Display Font for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.**

DATA ENTRY TIMING


RAM ADDRESS
ADDRESS HOLD TIME
10μs MAX.
DATA IN
DATA HOLD TIME
CHIP SELECT
6μs MIN.
DATA ENTRY TIME
2.5μs *
READY
35μs
* IF CHIP SELECT = 0
AFTER THIS TIME,
CONTROLLER WILL
ENTER NEXT CHARACTER.

MAXIMUM DATA ENTRY TIMES OVER OPERATING TEMPERATURE RANGE

| DATA ENTRY MODE | | FUNCTION | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATA HOLD TIME* | DATA ENTRY | BS | HT | LF | CR | US | INSERT | DEL | VT | FF | RS |
| LEFT, SINGLE | 25μs | 250μs | 215μs | 235μs | 505μs | 220μs | 200μs | 665μs | 645μs | | | |
| LEFT, EXPANDED | 25μs | 345μs | 265μs | 265μs | 265μs | 245μs | 245μs | 705μs | 690μs | 250μs | 530μs | 245μs |
| RIGHT | 25μs | 480μs | 480μs | | 485μs | | | | | | | |
| RAM | 25μs 145μs** | 220μs | | | | | | | | | | |
| BLOCK | 25μs | 130μs (165μs FOLLOWING RIGHTMOST CHARACTER) | | | | | | | | | | |
| CONTROL | 25μs | 545μs | | | | | | | | | | |
| DATA OUT | 25μs | 280μs + 36nμs, WHERE n = CONFIGURED DISPLAY LENGTH | | | | | | | | | | |

*MINIMUM TIME THAT DATA INPUTS MUST REMAIN VALID AFTER CHIP SELECT GOES LOW.

**MINIMUM TIME THAT RAM ADDRESS INPUTS MUST REMAIN VALID AFTER CHIP SELECT GOES LOW.

**Figure 6. Data Entry Timing and Data Entry Times for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.**

### Left Entry Mode

With Left entry, characters are entered in typewriter fashion, i.e., to the right of all previous characters. Left entry uses a blinking cursor to indicate the location where the next character is to be entered. CLEAR loads the display with spaces and resets the cursor to the leftmost display location. BACKSPACE and FORWARDSPACE move the cursor without changing the character string. Thus, the user can backspace to the character to be edited, enter a character and then forwardspace the cursor. CARRIAGE RETURN resets the cursor to the leftmost display location leaving the display unchanged. The DELETE function deletes the displayed character at the cursor location and then shifts the character string following the cursor one location to the left to fill the void of the deleted character. The INSERT CHARACTER sets a flag inside the system that causes subsequent ASCII characters to be inserted to the left of the character at the cursor location. As new characters are entered, the cursor, the character at the cursor, and all characters to the right of the cursor are shifted one location to the right. The INSERT function is terminated by a second INSERT CHARACTER, or by BACKSPACE, FORWARDSPACE, CLEAR, CARRIAGE RETURN, or DELETE. In Left entry mode, after the display is filled, the system ignores all characters except BACKSPACE, CARRIAGE RETURN, and CLEAR. The system allows the cursor to be positioned only in the region between the leftmost display character and immediately to the right (offscreen) of the rightmost display character.

Expanded Left entry is selected by grounding the $\overline{\text{EXPAND}}$ input prior to $\overline{\text{RESET}}$. Expanded Left entry mode allows several HDSP-87XX systems to be connected into a multiple line panel. Expanded Left entry uses the $\overline{\text{ERI}}$ input, $\overline{\text{ELI}}$ input, $\overline{\text{LEFT}}$ input, and $\overline{\text{ACTIVE}}$ output to provide a handshake between each system as shown in Figure 7. With the proper connections, the cursor can be moved in a circular fashion from the end of the last line to the beginning of the first line, or such that it shifts offscreen and is lost until the next CLEAR/HOME display command. Expanded Left entry adds three display commands: CURSOR UP moves the cursor to the same location in the preceeding line; CURSOR DOWN moves the cursor to the same location in the following line; CLEAR/HOME loads all displays with spaces and resets the cursor to the leftmost display location in the first line. The CLEAR command in Left entry mode is replaced by the LINE FEED function. LINE FEED moves the cursor to the leftmost display location in the following line leaving the current line unchanged.

### Right Entry Mode

In Right entry mode, characters are entered at the right hand side of the display and shifted to the left as new characters are entered. In this mode, the system stores 48 ASCII characters, although only the last characters entered are displayed. CLEAR loads the display with spaces. BACKSPACE shifts the display one location to the right, deleting the last character entered and displaying the next character in the 48 character buffer. Right entry mode is a simple means to implement the walking or "Times-Square" display. In this mode, the cursor is located immediately to the right (offscreen) of the rightmost displayed character.

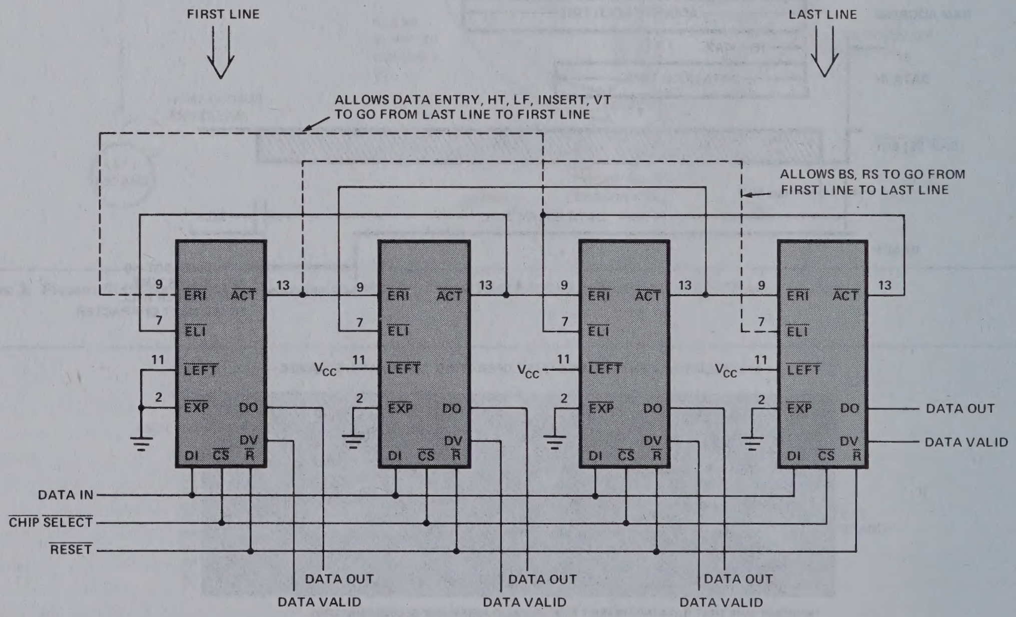

FIRST LINE
LAST LINE
ALLOWS DATA ENTRY, HT, LF, INSERT, VT TO GO FROM LAST LINE TO FIRST LINE
ALLOWS BS, RS TO GO FROM FIRST LINE TO LAST LINE
9
13
7
11
2
ERI
ACT
ELI
LEFT
EXP
DO
DV
DI
CS
R
VCC
DATA IN
CHIP SELECT
RESET
DATA OUT
DATA VALID

**Figure 7. External Connections for Expanded Left Entry Mode for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.**

### Block Entry Mode

Block entry allows the fastest data entry rate of all four modes. In this mode, characters are loaded from left to right as with Left entry. However, with Block entry, after the display is completely loaded, the next ASCII character is loaded in the leftmost display location, replacing the previous displayed character. While Block entry has a non-visible cursor, the cursor is always loaded with the address of the next character to be entered. The display can be cleared and the cursor reset to the leftmost display location by loading in a new BLOCK control word.

### RAM Entry Mode

In RAM entry, ASCII characters are loaded at the address specified by the six bit RAM address. Regardless of display length, address 00 is the leftmost display character. Out of range RAM addresses are ignored. While RAM entry has a non-visible cursor, the cursor is always preloaded with the address to the right of the last character entered. This allows the cursor to be preloaded with an address prior to going into any other entry mode. The display can be cleared by loading in a new RAM control word.

### Power-On Reset/$\overline{\text{Reset}}$

When power is first applied to the system, the system clears the display and tests the state of the DATA INPUT, $D_7$. If $D_7 > 2.0V$, the system loads the control word on the DATA INPUTS into the system. If $D_7 \leq 0.8V$ or the system sees an invalid control word, the system initializes as Left entry for a 40 character display with a flashing cursor in the leftmost location. During $\overline{\text{RESET}}$, the system also tests the state of the $\overline{\text{EXPAND}}$ input. If $\overline{\text{EXPAND}}$ is low, the system initializes in expanded left entry mode. A flow chart that describes the $\overline{\text{RESET}}$ function is shown in Figure 8. For POWER-ON RESET to function properly, the

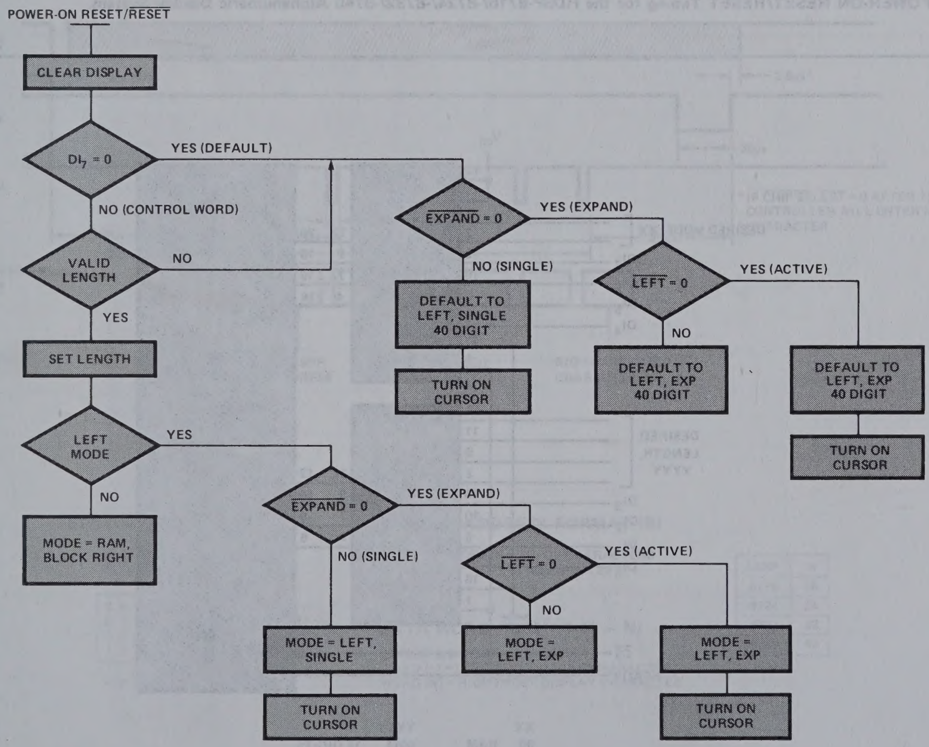
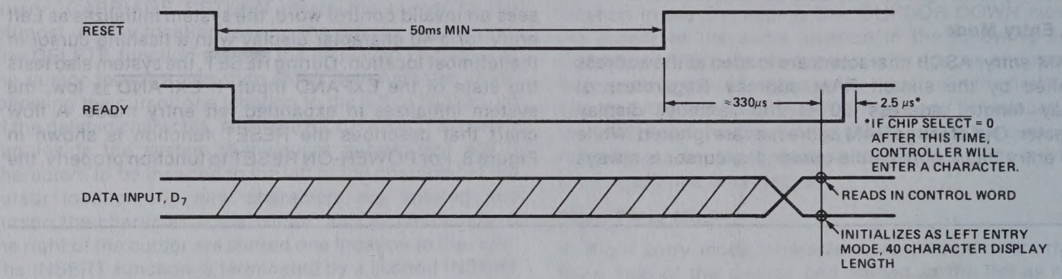

POWER-ON RESET/$\overline{\text{RESET}}$
CLEAR DISPLAY
$DI_7 = 0$
YES (DEFAULT)
NO (CONTROL WORD)
VALID LENGTH
NO
YES
SET LENGTH
LEFT MODE
YES
NO
MODE = RAM, BLOCK RIGHT
$\overline{\text{EXPAND}} = 0$
YES (EXPAND)
NO (SINGLE)
DEFAULT TO LEFT, SINGLE 40 DIGIT
TURN ON CURSOR
$\overline{\text{LEFT}} = 0$
YES (ACTIVE)
NO
DEFAULT TO LEFT, EXP 40 DIGIT
DEFAULT TO LEFT, EXP 40 DIGIT
TURN ON CURSOR
$\overline{\text{EXPAND}} = 0$
YES (EXPAND)
NO (SINGLE)
$\overline{\text{LEFT}} = 0$
YES (ACTIVE)
NO
MODE = LEFT, SINGLE
MODE = LEFT, EXP
MODE = LEFT, EXP
TURN ON CURSOR
TURN ON CURSOR

**Figure 8. Reset Sequence for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.**

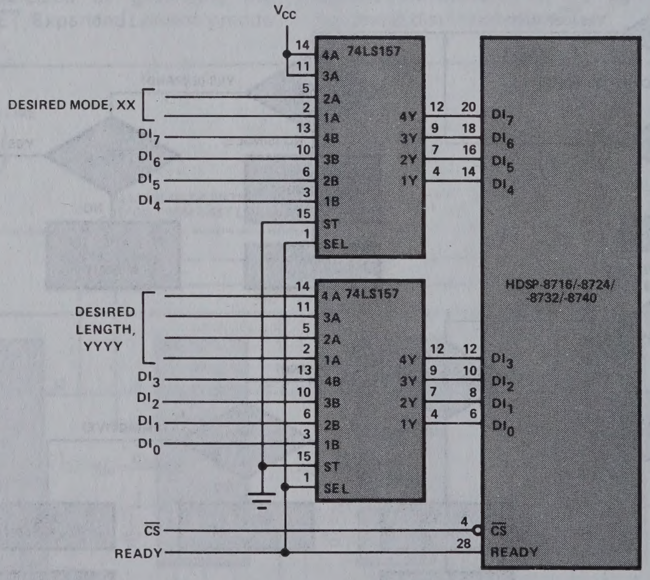
power supply must turn on at a rate > 100 V/s. In addition, the system can be reset by pulling the $\overline{\text{RESET}}$ input low for a minimum of 50 milliseconds. POWER-ON RESET/$\overline{\text{RESET}}$ timing is shown in Figure 9.

If some entry mode or display length is desired other than 40 character Left entry, it is necessary to either load the appropriate control word or provide a control word during POWER-ON RESET/$\overline{\text{RESET}}$. The circuit shown in Figure 10 can be used to load any desired preprogrammed control word into the HDSP-87XX Series Display Controller during POWER-ON RESET/$\overline{\text{RESET}}$.



$\overline{\text{RESET}}$
50ms MIN
READY
≈330μs
2.5 μs*
*IF $\overline{\text{CHIP SELECT}}$ = 0 AFTER THIS TIME, CONTROLLER WILL ENTER A CHARACTER.
DATA INPUT, $D_7$
READS IN CONTROL WORD
INITIALIZES AS LEFT ENTRY MODE, 40 CHARACTER DISPLAY LENGTH

Figure 9. POWER-ON RESET/$\overline{\text{RESET}}$ Timing for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.



$V_{CC}$
74LS157
4A
3A
2A
1A
4B
3B
2B
1B
ST
SEL
4Y
3Y
2Y
1Y
DESIRED MODE, XX
$DI_7$
$DI_6$
$DI_5$
$DI_4$
DESIRED LENGTH, YYYY
$DI_3$
$DI_2$
$DI_1$
$DI_0$
HDSP-8716/-8724/-8732/-8740
$\overline{\text{CS}}$
READY

| XX | | YYYY | |
|---|---|---|---|
| 00 | RAM | 0011 | 16 DIGITS |
| 01 | LEFT | 0101 | 24 DIGITS |
| 10 | RIGHT | 0111 | 32 DIGITS |
| 11 | BLOCK | 1001 | 40 DIGITS |

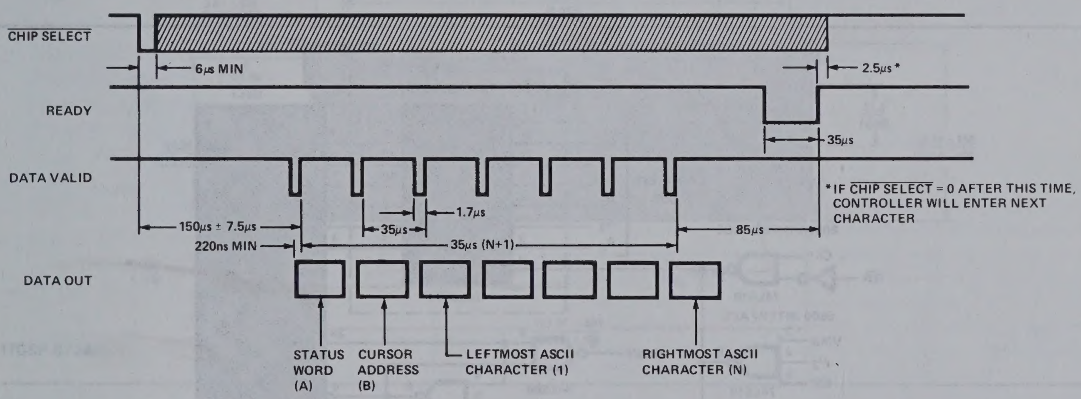
Figure 10. External Circuitry to Load a Control Word into the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System Upon POWER-ON RESET/$\overline{\text{RESET}}$.

**Data Out**

Data stored in the HDSP-87XX system is available to the user upon command. Data Out is initiated by the control word $1XXX11XX_2$. Following this control word, the system outputs a STATUS WORD, CURSOR ADDRESS, and a string of ASCII data characters. The STATUS WORD specifies the data entry mode and the display length of the system. The STATUS WORD is the same format as a valid control word with $D_7$ and $D_6$ deleted. The CURSOR ADDRESS specifies the location of the cursor within the display. The CURSOR ADDRESS of the leftmost display location is address 00. In Expanded Left entry mode, a CURSOR ADDRESS of 63 ($3F_{16}$) is used to indicate a non-active line. The system outputs the same number of ASCII data characters as the display length specified by the control word. The first ASCII data character is always the leftmost display character. The positive edge of the DATA VALID output can be used to load the DATA OUTPUT words into the user's system. The DATA OUT timing for the HDSP-87XX systems is summarized in Figure 11.

**Luminous Intensity Modulation**

Pulse width modulation of display luminous intensity can be provided by connecting the $\overline{\text{REFRESH}}$ output of the system to the input of a monostable multivibrator. The output of the monostable multivibrator should then be connected to the $\overline{\text{BLANK}}$ input of the system. Modulation of display luminous intensity is then achieved by varying the delay of the monostable multivibrator with a potentiometer or photoresistor. $\overline{\text{REFRESH}}$ is repeated at a rate of 10ms divided by the configured display length. For example, an HDSP-8732 system, when configured for a 32 character display length, would pulse the $\overline{\text{REFRESH}}$ output every 312.5μs. The circuit shown in Figure 12 may be utilized to provide manual control of display luminous intensity. Automatic control may be achieved by substituting an appropriate value photoconductor for potentiometer $R_1$. If luminous intensity modulation is not desired, $\overline{\text{BLANK}}$ should be left open.



*IF $\overline{\text{CHIP SELECT}}$ = 0 AFTER THIS TIME, CONTROLLER WILL ENTER NEXT CHARACTER

**STATUS WORD FORMAT (A)**

| $D_5$ $D_4$ | $D_3$ $D_2$ $D_1$ $D_0$ | |
|---|---|---|
| 0 0 | Y Y Y Y | RAM ENTRY |
| 0 1 | | LEFT ENTRY |
| 1 0 | | RIGHT ENTRY |
| 1 1 | | BLOCK ENTRY |

Y Y Y Y = DISPLAY LENGTH

**CURSOR ADDRESS FORMAT (B)**

CURSOR ADDRESS = NO. OF CHARACTERS FROM THE LEFT

| HDSP | N |
|---|---|
| -8716 | 16 |
| -8724 | 24 |
| -8732 | 32 |
| -8740 | 40 |

**DATA WORD FORMAT (1 – N)**

LOWEST 6 BITS OF ASCII CODE
WORD (1) = LEFTMOST DISPLAY CHARACTER
WORD (N) = RIGHTMOST DISPLAY CHARACTER

**Figure 11. Data Out Timing and Format for the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.**

## Microprocessor Interface

Interfacing the HDSP-87XX Series Display System to microprocessor systems depends on the needs of the particular application. Figure 13 shows a latched interface between the host microprocessor and the HDSP-87XX system. The latch provides temporary storage to avoid making the host microprocessor wait for the system to accept data. Data from the host microprocessor system is loaded into the 74LS273 octal register on the positive transition of the clock input (pin 11). At the same time, the $\overline{\text{CHIP SELECT}}$ input is forced low. The $\overline{\text{CHIP SELECT}}$ input stays low until READY goes low. The host microprocessor should avoid loading new data into the 74LS273 as long as BUSY is high. The latched interface can be implemented with an octal register and $\overline{\text{SR}}$ flip-flop if the HDSP-87XX system is operated in Left, Right, or Block entry. RAM entry requires an additional register for the RAM address inputs. Additional flexibility can be achieved by using a peripheral interface adapter (PIA) to interface the HDSP-87XX system to the host microprocessor system. The PIA provides a data entry handshake between the host microprocessor system and the HDSP-87XX system and allows the host microprocessor system to read the Data Output port of the HDSP-87XX system.

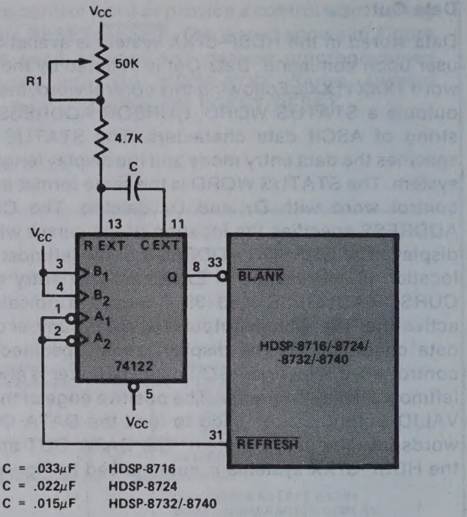
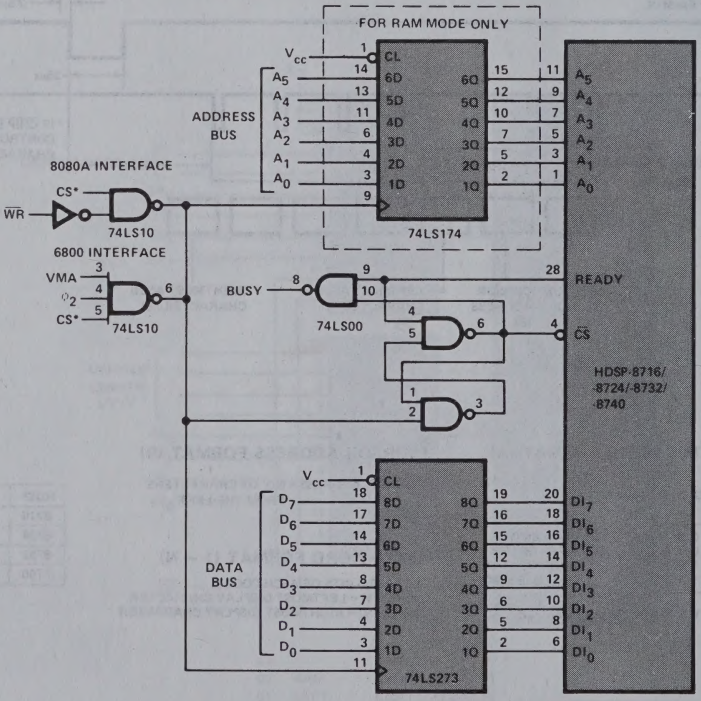

Vcc
50K
R1
4.7K
C
13
11
Vcc
R EXT
C EXT
3
B1
4
B2
1
A1
2
A2
Q
8
33
BLANK
74122
5
Vcc
31
REFRESH
HDSP-8716/-8724/-8732/-8740
C = .033μF HDSP-8716
C = .022μF HDSP-8724
C = .015μF HDSP-8732/-8740

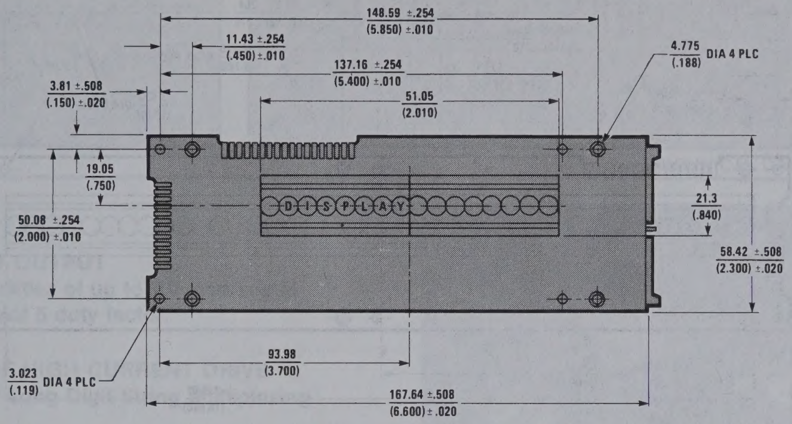
Figure 12. External Circuitry to Vary the Luminous Intensity of the HDSP-8716/-8724/-8732/-8740 Alphanumeric Display System.


FOR RAM MODE ONLY
Vcc
CL
ADDRESS BUS
A5
A4
A3
A2
A1
A0
6D
5D
4D
3D
2D
1D
6Q
5Q
4Q
3Q
2Q
1Q
74LS174
8080A INTERFACE
CS*
WR
74LS10
6800 INTERFACE
VMA
φ2
CS*
74LS10
BUSY
74LS00
READY
CS
HDSP-8716/-8724/-8732/-8740
DATA BUS
D7
D6
D5
D4
D3
D2
D1
D0
8D
7D
8Q
7Q
74LS273
DI7
DI6
DI5
DI4
DI3
DI2
DI1
DI0

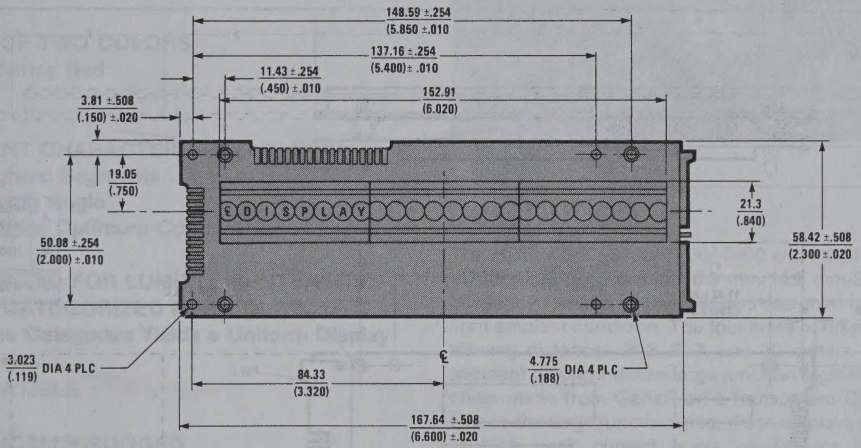
*CS IS A LOGICAL COMBINATION OF HIGH ORDER ADDRESS BITS THAT DISTINGUISH THE ADDRESS OF THE HDSP-8716/-8724/-8732/-8740 FROM THE REST OF THE MICROPROCESSOR SYSTEM.

Figure 13. Latched Interface to the HDSP-87XX Series Alphanumeric Display System.

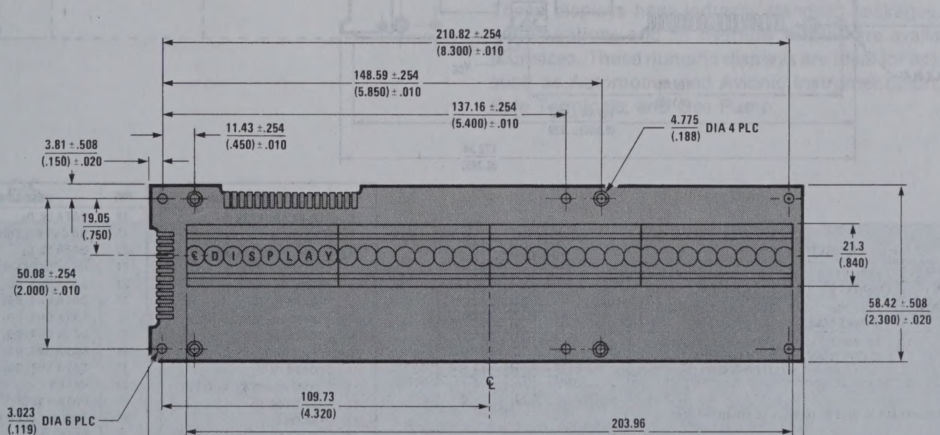
# Package Dimensions


148.59 ±.254
(5.850) ±.010
11.43 ±.254
(.450) ±.010
137.16 ±.254
(5.400) ±.010
51.05
(2.010)
4.775
(.188) DIA 4 PLC
3.81 ±.508
(.150) ±.020
19.05
(.750)
DISPLAY
21.3
(.840)
50.08 ±.254
(2.000) ±.010
58.42 ±.508
(2.300) ±.020
93.98
(3.700)
3.023
(.119) DIA 4 PLC
167.64 ±.508
(6.600) ±.020

**HDSP-8716**

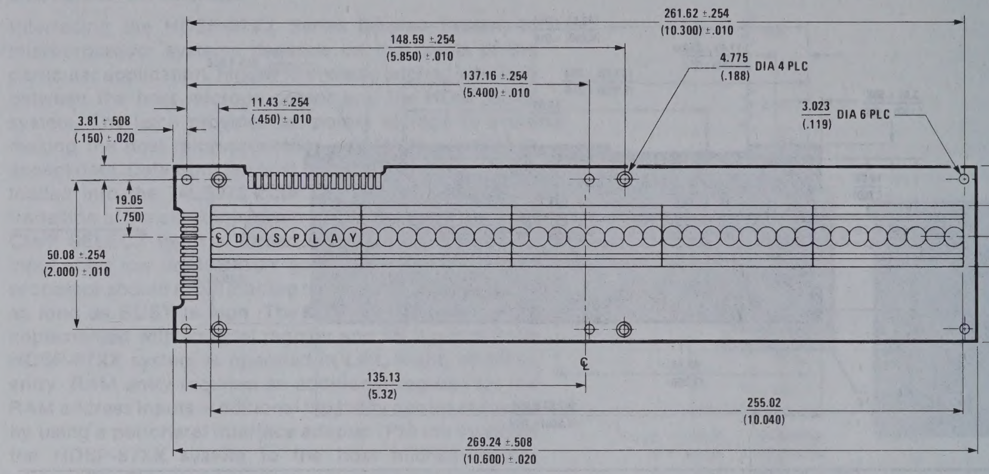

148.59 ±.254
(5.850 ±.010
137.16 ±.254
(5.400)± .010
11.43 ±.254
(.450) ±.010
152.91
(6.020)
3.81 ±.508
(.150) ±.020
19.05
(.750)
DISPLAY
21.3
(.840)
50.08 ±.254
(2.000) ±.010
58.42 ±.508
(2.300 ±.020
℄
3.023
(.119) DIA 4 PLC
4.775
(.188) DIA 4 PLC
84.33
(3.320)
167.64 ±.508
(6.600) ±.020

**HDSP-8724**

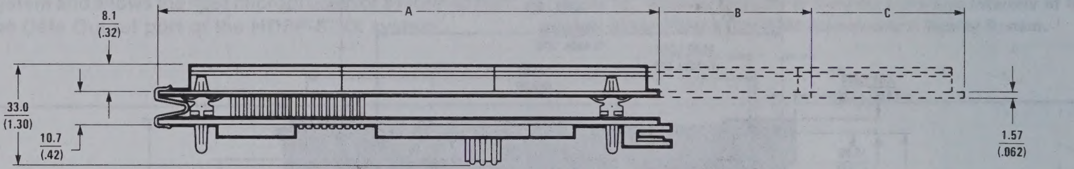

210.82 ±.254
(8.300) ±.010
148.59 ±.254
(5.850) ±.010
137.16 ±.254
(5.400) ±.010
11.43 ±.254
(.450) ±.010
4.775
(.188) DIA 4 PLC
3.81 ±.508
(.150) ±.020
19.05
(.750)
DISPLAY
21.3
(.840)
50.08 ±.254
(2.000) ±.010
58.42 ±.508
(2.300) ±.020
℄
109.73
(4.320)
3.023
(.119) DIA 6 PLC
203.96
(8.030)
218.44 ±.508
(8.600) ±.020

**HDSP-8732**

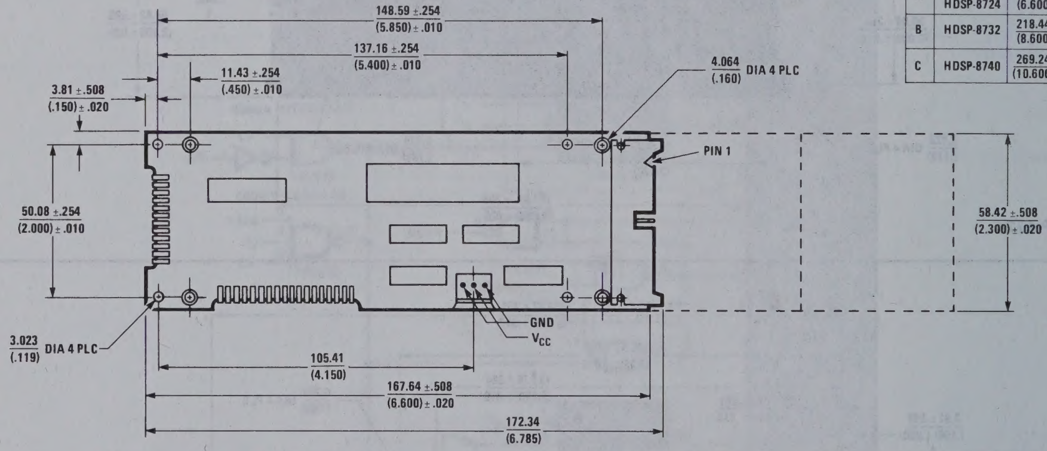
# Package Dimensions


261.62 ±.254
(10.300) ±.010
148.59 ±.254
(5.850) ±.010
4.775
(.188)
DIA 4 PLC
137.16 ±.254
(5.400) ±.010
11.43 ±.254
(.450) ±.010
3.81 ±.508
(.150) ±.020
3.023
(.119)
DIA 6 PLC
19.05
(.750)
50.08 ±.254
(2.000) ±.010
DISPLAY
21.3
(.840)
58.42 ±.508
(2.300) ±.020
℄
135.13
(5.32)
255.02
(10.040)
269.24 ±.508
(10.600) ±.020

**HDSP-8740**


A
B
C
8.1
(.32)
33.0
(1.30)
10.7
(.42)
1.57
(.062)

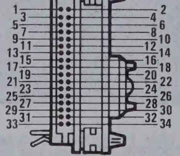
| | | |
|---|---|---|
| A | HDSP-8716<br>HDSP-8724 | 167.64<br>(6.600) |
| B | HDSP-8732 | 218.44<br>(8.600) |
| C | HDSP-8740 | 269.24<br>(10.600) |


148.59 ±.254
(5.850) ±.010
137.16 ±.254
(5.400) ±.010
11.43 ±.254
(.450) ±.010
3.81 ±.508
(.150) ±.020
4.064
(.160)
DIA 4 PLC
PIN 1
50.08 ±.254
(2.000) ±.010
58.42 ±.508
(2.300) ±.020
GND
$V_{CC}$
3.023
(.119)
DIA 4 PLC
105.41
(4.150)
167.64 ±.508
(6.600) ±.020
172.34
(6.785)

CONNECTORS

| FUNCTION | TYPE OF CONNECTOR | SUGGESTED MANUFACTURER |
|---|---|---|
| CONTROL/DATA ENTRY | 34 PIN RIBBON CABLE | 3M P/N 3414-X000 SERIES |
| POWER(1) | 3 PIN WITH LOCKING RAMP | MOLEX P/N 09-50-3031 WITH 08-50-0106 TERMINALS |

NOTES: (1) POWER LEADS SHOULD BE 18-20 GAUGE STRANDED WIRE.


1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34

| PIN | DESCRIPTION |
|---|---|
| 1 | RAM ADDRESS, $A_0$ |
| 2 | $\overline{\text{EXPAND}}$ |
| 3 | RAM ADDRESS, $A_1$ |
| 4 | $\overline{\text{CHIP SELECT}}$ |
| 5 | RAM ADDRESS, $A_2$ |
| 6 | DATA IN, $D_0$ |
| 7 | RAM ADDRESS, $A_3$ (ELI) |
| 8 | DATA IN, $D_1$ |
| 9 | RAM ADDRESS, $A_4$ (ERI) |
| 10 | DATA IN, $D_2$ |
| 11 | RAM ADDRESS, $A_5$ (LEFT) |
| 12 | DATA IN, $D_3$ |
| 13 | $\overline{\text{ACTIVE}}$ |
| 14 | DATA IN, $D_4$ |
| 15 | $\overline{\text{RESET}}$ |
| 16 | DATA IN, $D_5$ |
| 17 | NO CONNECTION |
| 18 | DATA IN, $D_6$ |
| 19 | NO CONNECTION |
| 20 | DATA IN, $D_7$ |
| 21 | NO CONNECTION |
| 22 | DATA OUT, $DO_0$ |
| 23 | DATA OUT, $DO_1$ |
| 24 | DATA OUT, $DO_2$ |
| 25 | DATA OUT, $DO_3$ |
| 26 | DATA OUT, $DO_4$ |
| 27 | DATA OUT, $DO_5$ |
| 28 | READY |
| 29 | DATA VALID |
| 30 | 400 kHz CLOCK OUT |
| 31 | $\overline{\text{REFRESH}}$ |
| 32 | NO CONNECTION |
| 33 | $\overline{\text{DISPLAY BLANK}}$ |
| 34 | NO CONNECTION |

**HDSP-8716/-8724/-8732/-8740**

**HEWLETT PACKARD**

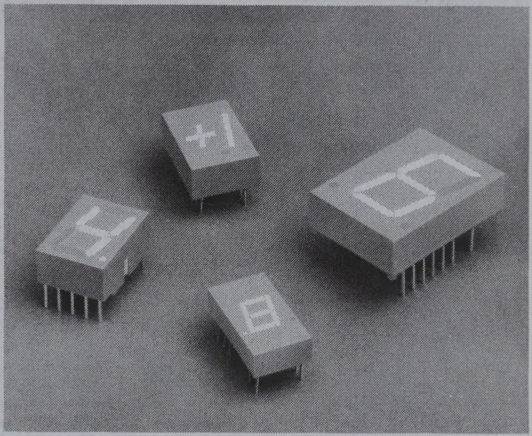
# SEVEN SEGMENT DISPLAYS FOR HIGH LIGHT AMBIENT CONDITIONS

## HIGH EFFICIENCY RED HDSP-3530/-3730/-5530/-3900 SERIES
## YELLOW HDSP-4030/-4130/-5730/-4200 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **HIGH LIGHT OUTPUT**
  Typical Intensities of up to 7.0 mcd/seg at 100 mA pk 1 of 5 duty factor.
- **CAPABLE OF HIGH CURRENT DRIVE**
  Excellent for Long Digit String Multiplexing
- **FOUR CHARACTER SIZES**
  7.6 mm, 10.9 mm, 14.2 mm, and 20.3 mm
- **CHOICE OF TWO COLORS**
  High Efficiency Red
  Yellow
- **EXCELLENT CHARACTER APPEARANCE**
  Evenly Lighted Segments
  Wide Viewing Angle
  Grey Body for Optimum Contrast
- **CATEGORIZED FOR LUMINOUS INTENSITY; YELLOW CATEGORIZED FOR COLOR**
  Use of Like Categories Yields a Uniform Display
- **IC COMPATIBLE**
- **MECHANICALLY RUGGED**



## Description

The HDSP-3530/-3730/-5530/-3900 and HDSP-4030/-4130/-5730/-4200 are 7.6 mm, 10.9 mm/14.2 mm/20.3 mm high efficiency red and yellow displays designed for use in high light ambient condition. The four sizes of displays allow for viewing distances at 3, 6, 7, and 10 meters. These seven segment displays utilize large junction high efficiency LED chips made from GaAsP on a transparent GaP substrate. Due to the large junction area, these displays can be driven at high peak current levels needed for high ambient conditions or many character multiplexed operation.

These displays have industry standard packages, and pin configurations and ±1 overflow display are available in all four sizes. These numeric displays are ideal for applications such as Automotive and Avionic Instrumentation, Point of Sale Terminals, and Gas Pump.

## Devices

| Part No. HDSP- | Color | Description | Package Drawing |
|---|---|---|---|
| 3530 | High Efficiency Red | 7.6 mm Common Anode Left Hand Decimal | A |
| 3531 | | 7.6 mm Common Anode Right Hand Decimal | B |
| 3533 | | 7.6 mm Common Cathode Right Hand Decimal | C |
| 3536 | | 7.6 mm Universal Overflow ±1 Right Hand Decimal | D |
| 4030 | Yellow | 7.6 mm Common Anode Left Hand Decimal | A |
| 4031 | | 7.6 mm Common Anode Right Hand Decimal | B |
| 4033 | | 7.6 mm Common Cathode Right Hand Decimal | C |
| 4036 | | 7.6 mm Universal Overflow ±1 Right Hand Decimal | D |

Note: Universal pinout brings the anode and cathode of each segment's LED out to separate pins. See internal diagrams D and H.

## Devices

| Part No. HDSP | Color | Description | Package Drawing |
|---|---|---|---|
| 3730 | High Efficiency Red | 10.9 mm Common Anode Left Hand Decimal | E |
| 3731 | | 10.9 mm Common Anode Right Hand Decimal | F |
| 3733 | | 10.9 mm Common Cathode Right Hand Decimal | G |
| 3736 | | 10.9 mm Universal Overflow ±1 Right Hand Dec. | H |
| 4130 | Yellow | 10.9 mm Common Anode Left Hand Decimal | E |
| 4131 | | 10.9 mm Common Anode Right Hand Decimal | F |
| 4133 | | 10.9 mm Common Cathode Right Hand Decimal | G |
| 4136 | | 10.9 mm Universal Overflow ±1 Right Hand Dec. | H |
| 5531 | High Efficiency Red | 14.2 mm Common Anode Right Hand Decimal | I |
| 5533 | | 14.2 mm Common Cathode Right Hand Decimal | J |
| 5537 | | 14.2 mm Overflow ±1 Common Anode | K |
| 5538 | | 14.2 mm Overflow ±1 Common Cathode | L |
| 5731 | Yellow | 14.2 mm Common Anode Right Hand Decimal | I |
| 5733 | | 14.2 mm Common Cathode Right Hand Decimal | J |
| 5737 | | 14.2 mm Overflow ±1 Common Anode | K |
| 5738 | | 14.2 mm Overflow ±1 Common Cathode | L |
| 3900 | High Efficiency Red | 20.3 mm Common Anode Left Hand Decimal | M |
| 3901 | | 20.3 mm Common Anode Right Hand Decimal | N |
| 3903 | | 20.3 mm Common Cathode Right Hand Decimal | O |
| 3905 | | 20.3 mm Common Cathode Left Hand Decimal | P |
| 3906 | | 20.3 mm Universal Overflow ±1 Right Hand Decimal | Q |
| 4200 | Yellow | 20.3 mm Common Anode Left Hand Decimal | M |
| 4201 | | 20.3 mm Common Anode Right Hand Decimal | N |
| 4203 | | 20.3 mm Common Cathode Right Hand Decimal | O |
| 4205 | | 20.3 mm Common Cathode Left Hand Decimal | P |
| 4206 | | 20.3 mm Universal Overflow ±1 Right Hand Decimal | Q |

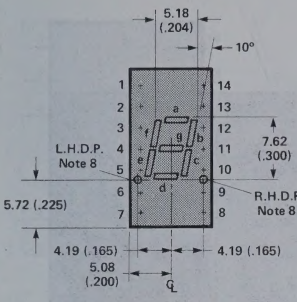
Note: Universal pinout brings the anode and cathode of each segment's LED out to separate pins. See internal diagram Q.

## Absolute Maximum Ratings (All Products)

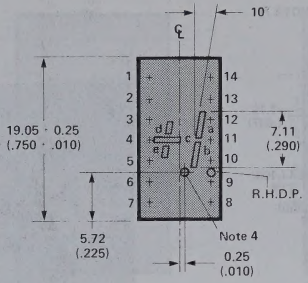
| | |
|---|---|
| Average Power per Segment or DP ($T_A = 25°C$) | 105 mW |
| Peak Forward Current per Segment or DP ($T_A = 25°C$)[1] | 135 mA<br>(Pulse Width = 0.16 ms) |
| DC Forward Current per Segment[2] or DP ($T_A = 25°C$) | 40 mA |
| Operating Temperature Range | -40°C to +85°C |
| Storage Temperature Range | -40°C to +85°C |
| Reverse Voltage per Segment or DP | 5.0V |
| Lead Solder Temperature (1.59 mm [1/16 inch] below seating plane) | 260°C for 3 sec. |

Notes:
1. See Figure 1 to establish pulsed operating conditions.
2. Derate maximum DC current above $T_A$ = 25°C at .50 mA/°C per segment, see Figure 2.

# Package Dimensions (HDSP-3530/4030 Series)

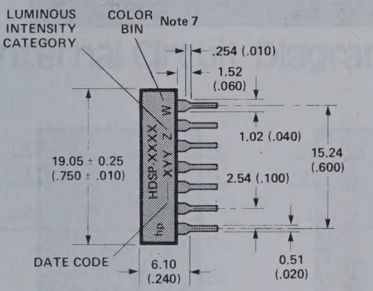

5.18
(.204)
10°
1
2
3
4
5
6
7
14
13
12
11
10
9
8
a
f
g
b
e
c
d
7.62
(.300)
L.H.D.P.
Note 8
R.H.D.P.
Note 8
5.72 (.225)
4.19 (.165)
4.19 (.165)
5.08
(.200)
℄

A,B,C

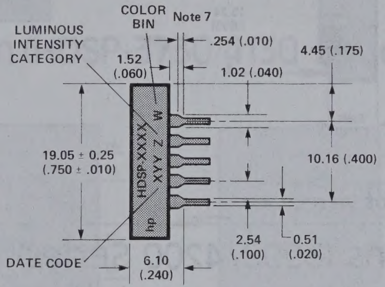

10°
℄
19.05 ± 0.25
(.750 ± .010)
1
2
3
4
5
6
7
14
13
12
11
10
9
8
d
e
c
b
a
7.11
(.290)
R.H.D.P.
5.72
(.225)
Note 4
0.25
(.010)

D

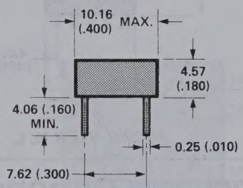
| PIN | FUNCTION<br>A<br>-3530/-4030 | <br>B<br>-3531/-4031 | <br>C<br>-3533/-4033 | <br>D<br>-3536/-4036 |
|---|---|---|---|---|
| 1 | CATHODE-a | CATHODE-a | CATHODE[6] | ANODE-d |
| 2 | CATHODE-f | CATHODE-f | ANODE-f | NO PIN |
| 3 | ANODE[3] | ANODE[3] | ANODE-g | CATHODE-d |
| 4 | NO PIN | NO PIN | ANODE-e | CATHODE-c |
| 5 | NO PIN | NO PIN | ANODE-d | CATHODE-e |
| 6 | CATHODE-dp | NO CONN.[5] | CATHODE[6] | ANODE-e |
| 7 | CATHODE-e | CATHODE-e | ANODE-dp | ANODE-c |
| 8 | CATHODE-d | CATHODE-d | ANODE-c | ANODE-dp |
| 9 | NO CONN.[5] | CATHODE-dp | ANODE-b | NO PIN |
| 10 | CATHODE-c | CATHODE-c | ANODE-a | CATHODE-dp |
| 11 | CATHODE-g | CATHODE-g |  | CATHODE-b |
| 12 | NO PIN | NO PIN |  | CATHODE-a |
| 13 | CATHODE-b | CATHODE-b |  | ANODE-a |
| 14 | ANODE[3] | ANODE[3] |  | ANODE-b |


LUMINOUS
INTENSITY
CATEGORY
COLOR
BIN
Note 7
.254 (.010)
1.52
(.060)
1.02 (.040)
19.05 ± 0.25
(.750 ± .010)
15.24
(.600)
2.54 (.100)
HDSP-XXXX
XYY Z
M
hp
DATE CODE
6.10
(.240)
0.51
(.020)

A,B,D
SIDE

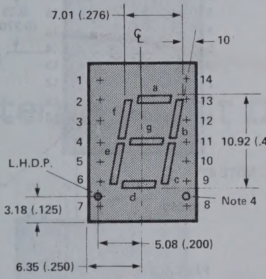

COLOR
BIN
Note 7
LUMINOUS
INTENSITY
CATEGORY
.254 (.010)
1.52
(.060)
4.45 (.175)
1.02 (.040)
19.05 ± 0.25
(.750 ± .010)
10.16 (.400)
HDSP-XXXX
XYY Z
M
hp
2.54
(.100)
0.51
(.020)
DATE CODE
6.10
(.240)

C
SIDE

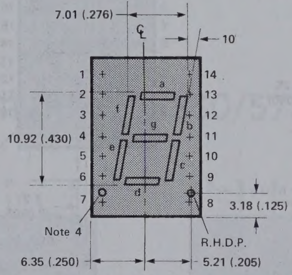

10.16
(.400)
MAX.
4.57
(.180)
4.06 (.160)
MIN.
0.25 (.010)
7.62 (.300)

A,B,C,D
END

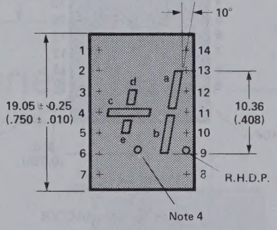
# Package Dimensions (HDSP-3730/4130 Series)


7.01 (.276)
℄
10°
1
2
3
4
5
6
7
14
13
12
11
10
9
8
a
f
g
b
e
c
d
10.92 (.430)
L.H.D.P.
Note 4
3.18 (.125)
5.08 (.200)
6.35 (.250)

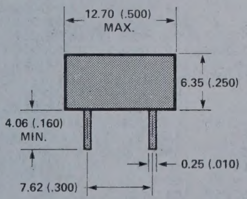
E


7.01 (.276)
℄
10°
1
2
3
4
5
6
7
14
13
12
11
10
9
8
a
f
g
b
e
c
d
10.92 (.430)
3.18 (.125)
Note 4
R.H.D.P.
6.35 (.250)
5.21 (.205)

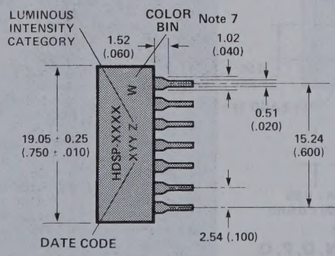
F,G
FRONT VIEW


10°
1
2
3
4
5
6
7
14
13
12
11
10
9
8
d
a
c
e
b
19.05 ± 0.25
(.750 ± .010)
10.36
(.408)
R.H.D.P.
Note 4

H


12.70 (.500)
MAX.
6.35 (.250)
4.06 (.160)
MIN.
0.25 (.010)
7.62 (.300)

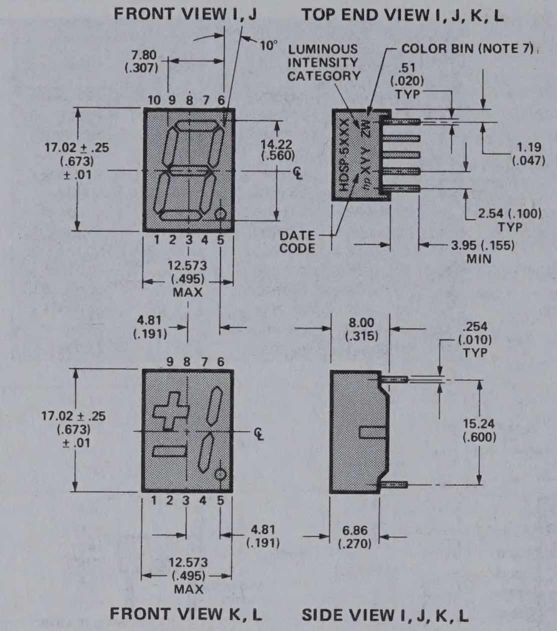
E, F, G, H
END VIEW


LUMINOUS
INTENSITY
CATEGORY
COLOR
BIN
Note 7
1.52
(.060)
1.02
(.040)
0.51
(.020)
19.05 ± 0.25
(.750 ± .010)
15.24
(.600)
HDSP-XXXX
XYY Z
M
DATE CODE
2.54 (.100)

E, F, G, H
SIDE VIEW

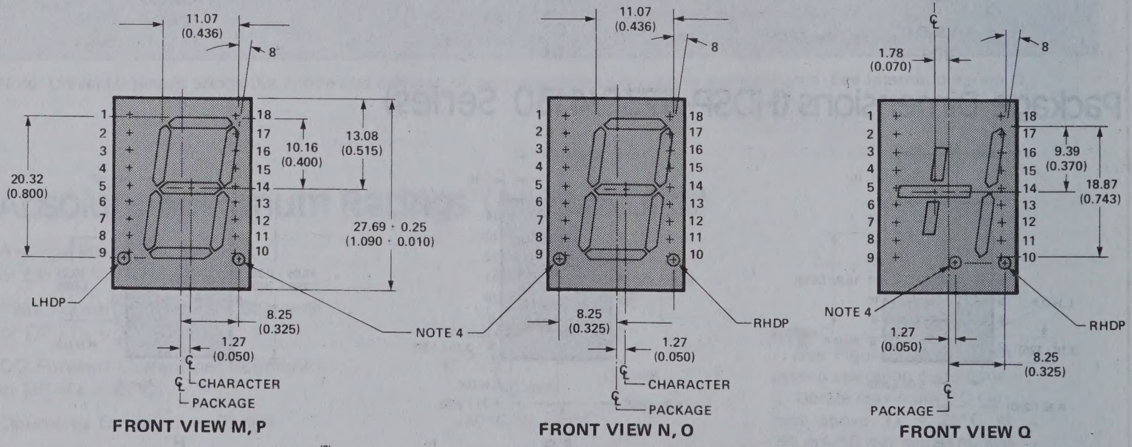
| PIN | FUNCTION<br>E<br>-3730/-4130 | <br>F<br>-3731/-4131 | <br>G<br>-3733/-4133 | <br>H<br>-3736/-4136 |
|---|---|---|---|---|
| 1 | CATHODE-a | CATHODE-a | ANODE-a | CATHODE-d |
| 2 | CATHODE-f | CATHODE-f | ANODE-f | ANODE-d |
| 3 | ANODE[3] | ANODE[3] | CATHODE[6] | NO PIN |
| 4 | NO PIN | NO PIN | NO PIN | CATHODE-c |
| 5 | NO PIN | NO PIN | NO PIN | CATHODE-e |
| 6 | CATHODE-dp | NO CONN.[5] | NO CONN.[5] | ANODE-e |
| 7 | CATHODE-e | CATHODE-e | ANODE-e | ANODE-c |
| 8 | CATHODE-d | CATHODE-d | ANODE-d | ANODE-dp |
| 9 | NO CONN.[5] | CATHODE-dp | ANODE-dp | CATHODE-dp |
| 10 | CATHODE-c | CATHODE-c | ANODE-c | CATHODE-b |
| 11 | CATHODE-g | CATHODE-g | ANODE-g | CATHODE-a |
| 12 | NO PIN | NO PIN | NO PIN | NO PIN |
| 13 | CATHODE-b | CATHODE-b | ANODE-b | ANODE-a |
| 14 | ANODE[3] | ANODE[3] | CATHODE[6] | ANODE-b |

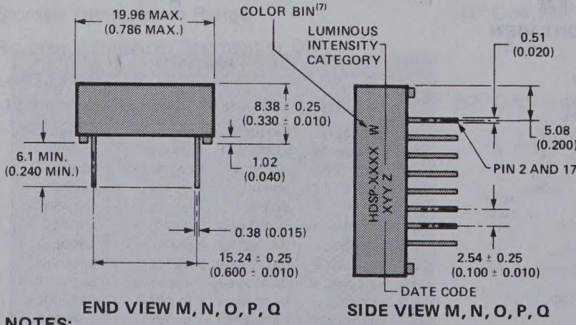
# Package Dimensions (5530/5730 Series)


FRONT VIEW I, J
TOP END VIEW I, J, K, L
10°
7.80 (.307)
LUMINOUS INTENSITY CATEGORY
COLOR BIN (NOTE 7)
.51 (.020) TYP
10 9 8 7 6
17.02 ± .25 (.673) ± .01
14.22 (.560)
℄
HDSP 5XXX
XYY Z W
1.19 (.047)
2.54 (.100) TYP
1 2 3 4 5
DATE CODE
3.95 (.155) MIN
12.573 (.495) MAX
4.81 (.191)
8.00 (.315)
.254 (.010) TYP
9 8 7 6
17.02 ± .25 (.673) ± .01
℄
15.24 (.600)
1 2 3 4 5
4.81 (.191)
6.86 (.270)
12.573 (.495) MAX
FRONT VIEW K, L
SIDE VIEW I, J, K, L

| PIN | FUNCTION | | | |
|---|---|---|---|---|
| | I | J | K | L |
| 1 | CATHODE e | ANODE e | CATHODE c | ANODE c |
| 2 | CATHODE d | ANODE d | ANODE c, d | CATHODE c, d |
| 3 | ANODE(3) | CATHODE(6) | CATHODE b | ANODE b |
| 4 | CATHODE c | ANODE c | ANODE a, b DP | CATHODE a, b, DP |
| 5 | CATHODE DP | ANODE DP | CATHODE DP | ANODE DP |
| 6 | CATHODE b | ANODE b | CATHODE a | ANODE a |
| 7 | CATHODE a | ANODE a | ANODE a, b, DP | CATHODE a, b, DP |
| 8 | ANODE(3) | CATHODE(6) | ANODE c, d | CATHODE c, d |
| 9 | CATHODE f | ANODE f | CATHODE d | ANODE d |
| 10 | CATHODE g | ANODE g | NO PIN(5) | NO PIN(5) |

# Package Dimensions (3900/4200 Series)


11.07 (0.436)
8
1 2 3 4 5 6 7 8 9
18 17 16 15 14 13 12 11 10
20.32 (0.800)
10.16 (0.400)
13.08 (0.515)
27.69 ± 0.25 (1.090 ± 0.010)
LHDP
8.25 (0.325)
1.27 (0.050)
NOTE 4
℄ CHARACTER
℄ PACKAGE
FRONT VIEW M, P
11.07 (0.436)
8
RHDP
8.25 (0.325)
1.27 (0.050)
℄ CHARACTER
℄ PACKAGE
FRONT VIEW N, O
℄
1.78 (0.070)
8
9.39 (0.370)
18.87 (0.743)
NOTE 4
RHDP
1.27 (0.050)
8.25 (0.325)
PACKAGE ℄
FRONT VIEW Q

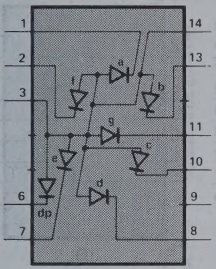

19.96 MAX. (0.786 MAX.)
COLOR BIN(7)
LUMINOUS INTENSITY CATEGORY
0.51 (0.020)
8.38 ± 0.25 (0.330 ± 0.010)
5.08 (0.200)
6.1 MIN. (0.240 MIN.)
1.02 (0.040)
HDSP-XXXX W
XYY Z
PIN 2 AND 17
0.38 (0.015)
15.24 ± 0.25 (0.600 ± 0.010)
2.54 ± 0.25 (0.100 ± 0.010)
DATE CODE
END VIEW M, N, O, P, Q
SIDE VIEW M, N, O, P, Q

| Pin | Function | | | | |
|---|---|---|---|---|---|
| | M<br>3900/4200 | N<br>3901/4201 | O<br>3903/4303 | P<br>3905/4205 | Q<br>3906/4206 |
| 1 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |
| 2 | CATHODE a | CATHODE a | ANODE a | ANODE a | CATHODE a |
| 3 | CATHODE f | CATHODE f | ANODE f | ANODE f | ANODE d |
| 4 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE d |
| 5 | CATHODE e | CATHODE e | ANODE e | ANODE e | CATHODE c |
| 6 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE e |
| 7 | CATHODE dp | NO. CONNEC. | NO. CONNEC. | ANODE dp | ANODE e |
| 8 | NO PIN | NO PIN | NO PIN | NO PIN | CATHODE dp |
| 9 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |
| 10 | NO PIN | CATHODE dp | ANODE dp | NO PIN | ANODE dp |
| 11 | CATHODE d | CATHODE d | ANODE d | ANODE d | CATHODE dp |
| 12 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE b |
| 13 | CATHODE c | CATHODE c | ANODE c | ANODE c | ANODE b |
| 14 | CATHODE g | CATHODE g | ANODE g | ANODE g | ANODE c |
| 15 | CATHODE b | CATHODE b | ANODE b | ANODE b | ANODE a |
| 16 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |
| 17 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE a |
| 18 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |

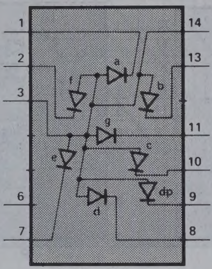
**NOTES:**

1. Dimensions in millimeters and (inches).
2. All untoleranced dimensions are for reference only.
3. Redundant anodes.
4. Unused dp position.
5. See Internal Circuit Diagram.
6. Redundant Cathodes.
7. For HDSP-4030/-4130/-5730/-4200 Series product only.
8. See part number table for LHDP and RHDP designation.

# Internal Circuit Diagram (HDSP-3530/4030 Series)


1
2
3
6
7
14
13
11
10
9
8
a
b
c
d
e
f
g
dp

A


1
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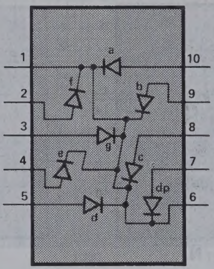
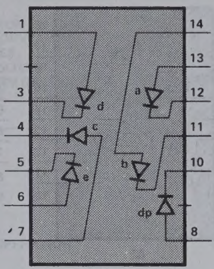
6
7
14
13
11
10
9
8
a
b
c
d
e
f
g
dp

B

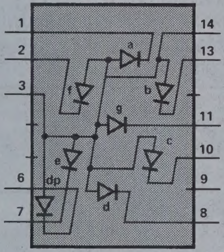

1
2
3
4
5
10
9
8
7
6
a
b
c
d
e
f
g
dp

C

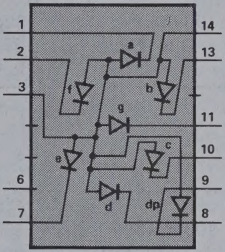

1
3
4
5
6
7
14
13
12
11
10
8
a
b
c
d
e
dp

D

# Internal Circuit Diagram (HDSP-3730/4130 Series)


1
2
3
6
7
14
13
11
10
9
8
a
b
c
d
e
f
g
dp

E


1
2
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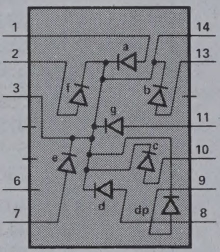
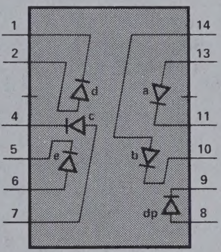
6
7
14
13
11
10
9
8
a
b
c
d
e
f
g
dp

F

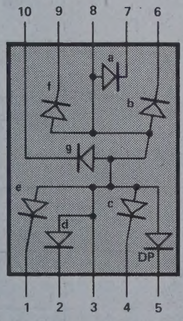

1
2
3
6
7
14
13
11
10
9
8
a
b
c
d
e
f
g
dp

G

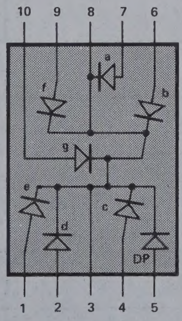

1
2
4
5
6
7
14
13
11
10
9
8
a
b
c
d
e
dp

H

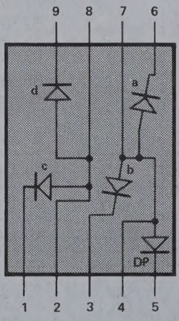
# Internal Circuit Diagram (HDSP-5530/5730 Series)


10
9
8
7
6
a
f
b
g
e
d
c
DP
1
2
3
4
5

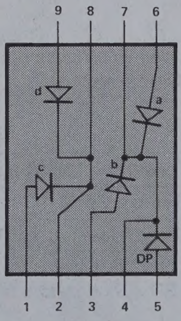
I


10
9
8
7
6
a
f
b
g
e
d
c
DP
1
2
3
4
5

J

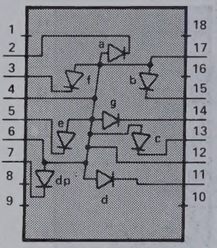

9
8
7
6
d
a
c
b
DP
1
2
3
4
5

K


9
8
7
6
d
a
c
b
DP
1
2
3
4
5

L

# Internal Circuit Diagram (HDSP-3900/4200 Series)


1
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9
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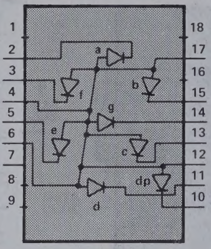
17
16
15
14
13
12
11
10
a
b
f
g
e
c
dp
d

M


1
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10
a
b
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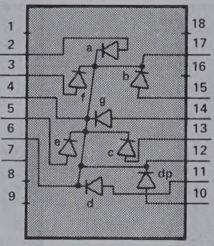
g
e
c
dp
d

N


1
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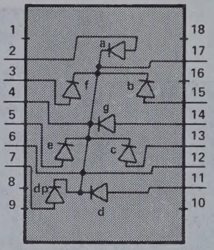
18
17
16
15
14
13
12
11
10
a
b
f
g
e
c
dp
d

O


1
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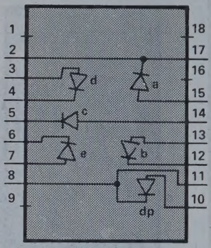
9
18
17
16
15
14
13
12
11
10
a
b
f
g
e
c
dp
d

P


1
2
3
4
5
6
7
8
9
18
17
16
15
14
13
12
11
10
d
a
c
e
b
dp

Q

# Electrical/Optical Characteristics at $T_A = 25°C$

| Parameter | Symbol | Device HDSP- | Test Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| Luminous Intensity/ Segment[9,10] (Digit Average) | $I_V$ | 3530<br>3730<br>5530<br>3900 | 100 mA Pk; 1 of 5 Duty Factor | 1500<br>1500<br>2200<br>2200 | 4500<br>5000<br>7000<br>7000 | | μcd |
| | | 3530<br>3730<br>5530<br>3900 | 20 mA DC | | 3100<br>3500<br>4800<br>4800 | | μcd |
| | | 4030<br>4130<br>5730<br>4200 | 100 mA Pk; 1 of 5 Duty Factor | 1500<br>1500<br>2200<br>2200 | 4500<br>5000<br>7000<br>7000 | | μcd |
| | | 4030<br>4130<br>5730<br>4200 | 20 mA DC | | 2200<br>2500<br>3400<br>3400 | | μcd |
| Peak Wavelength | $\lambda_{PEAK}$ | 3530/3730/ 5530/3900 | | | 635 | | nm |
| | | 4030/4130/ 5730/4200 | | | 583 | | nm |
| Dominant Wavelength[11, 12] (Digit Average) | $\lambda_d$ | 3530/3730/ 5530/3900 | | | 626 | | nm |
| | | 4030/4130/ 5730/4200 | | 581.5 | 586 | 592.5 | nm |
| Forward Voltage/Seg or D.P. | $V_F$ | All Devices | $I_F = 100$ mA | | 2.6 | 3.5 | V |
| Reverse Current/Seg or D.P. | $I_R$ | All Devices | $V_R = 3.0$ V | | | 100 | μA |
| Temp. Coeff. of $V_F$/Seg or D.P. | $\Delta V_F/°C$ | All Devices | $I_F = 100$ mA | | -1.1 | | mV/°C |
| Thermal Resistance LED Junction-to-pin | $R\theta_{J-PIN}$ | 3530/4030/ 3730/4130 | | | 282 | | °C/W/Seg |
| | | 5530/5730 | | | 345 | | °C/W/Seg |
| | | 3900/4200 | | | 375 | | °C/W/Seg |

**Notes:**

9. Case temperature of the device immediately prior to the intensity measurement is 25°C.
10. The digits are categorized for luminous intensity with the intensity category designated by a letter on the side of the package.
11. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and is that single wavelength which defines the color of the device.
12. The yellow displays are categorized as to dominant wavelength with the category designated by a number adjacent to the intensity category letter.

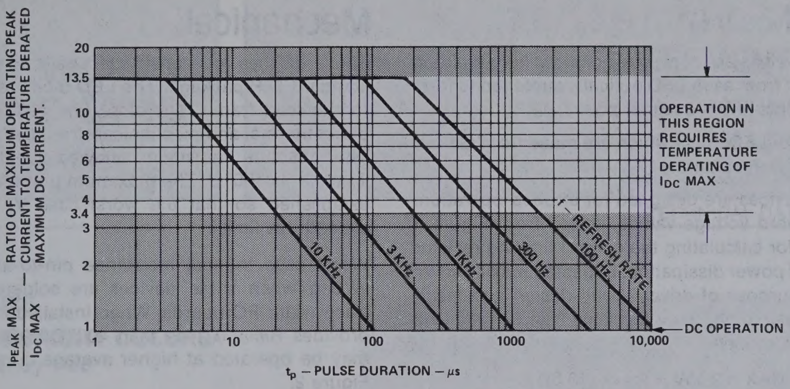


Figure 1. Maximum Allowed Peak Current vs. Pulse Duration

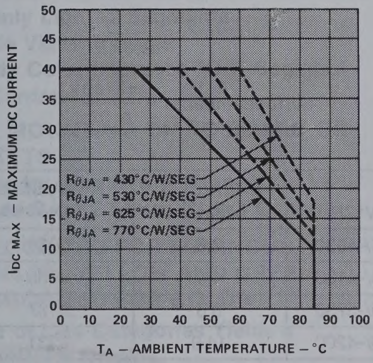


Figure 2. Maximum Allowable DC Current per Segment vs. Ambient Temperature

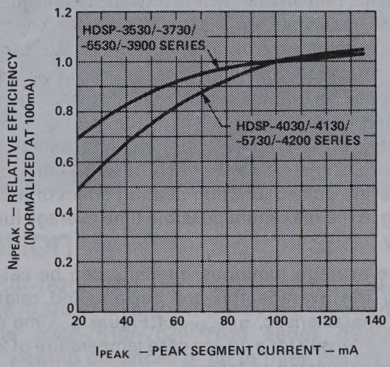


Figure 3. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current

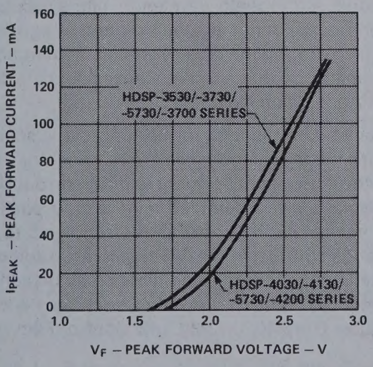


Figure 4. Peak Forward Segment Current vs. Peak Forward Voltage

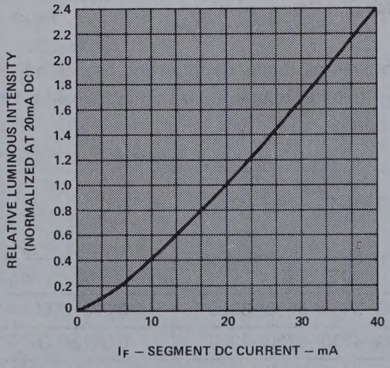


Figure 5. Relative Luminous Intensity vs. DC Forward Current

## Electrical

These display devices are composed of eight light emitting diodes, with light from each LED optically stretched to form individual segments and a decimal point.

The devices utilize LED chips which are made from GaAsP on a transparent GaP substrate.

These display devices are designed for strobed operation. The typical forward voltage values, scaled from Figure 4 should be used for calculating the current limiting resistor value and typical power dissipation. Expected maximum $V_F$ values, for the purpose of driver circuit design and maximum power dissipation, may be calculated using the following $V_F$ MAX models:

$$V_F \text{ MAX} = 2.15\text{V} + I_{PEAK}\ (13.5\Omega)$$
$$\text{For: } I_F \geq 30 \text{ mA}$$

$$V_F \text{ MAX} = 1.9\text{V} + I_{DC}\ (21.8\Omega)$$
$$\text{For: } 10 \text{ mA} \leq I_F \leq 30 \text{ mA}$$

Temperature derated strobed operating conditions are obtained from Figures 1 and 2. Figure 1 relates pulse duration ($t_p$), refresh rate (f), and the ratio of maximum peak current to maximum dc current ($I_{PEAK}$ MAX/$I_{DC}$ MAX). Figure 2 presents the maximum allowed dc current vs. ambient temperature. Figure 1 is based on the principle that the peak junction temperature for pulsed operation at a specified peak current, pulse duration and refresh rate should be the same as the junction temperature at maximum DC operation. Refresh rates of 1 kHz or faster minimize the pulsed junction heating effect of the device resulting in the maximum possible time average luminous intensity.

The time average luminous intensity can be calculated knowing the average forward current and relative efficiency characteristic, $\eta_{I_{PEAK}}$, of Figure 3. Time average luminous intensity for a device case temperature of 25° C, $I_V$ (25° C), is calculated as follows:

$$I_V\ (25°\text{C}) = \left[\frac{I_{AVG}}{20 \text{ mA}}\right]\left[\eta_{I_{PEAK}}\right]\left[I_{V \text{ DATA SHEET}}\right]$$

Example: For HDSP-4030 series

$$\eta_{I_{PEAK}} = 1.00 \text{ at } I_{PEAK} = 100 \text{ mA. For DF} = 1/5:$$

$$I_V\ (25°\text{C}) = \left[\frac{20 \text{ mA}}{20 \text{ mA}}\right]\left[1.00\right]\left[4.5 \text{ mcd}\right] = 4.5 \text{ mcd/segment}$$

The time average luminous intensity may be adjusted for operating junction temperature by the following exponential equation:

$$I_V\ (T_J) = I_V\ (25°\text{C})\ e^{[k(T_J + 25°\text{C})]}$$

where $T_J = T_A + P_D \cdot R\theta_{J\text{-}A}$

| DEVICE | K |
|---|---|
| -3530/-3730/-5530/-3900 | -0.0131/° C |
| -4030/-4130/-5730/-4200 | -0.0112/° C |

## Mechanical

These devices are constructed utilizing a lead frame in a standard DIP package. The LED dice are attached directly to the lead frame. Therefore, the cathode leads are the direct thermal and mechanical stress paths to the LED dice. The absolute maximum allowed junction temperature, $T_J$ MAX, is 105° C. The maximum power ratings have been established so that the worst case $V_F$ device does not exceed this limit.

Worst case thermal resistance pin-to-ambient is 400° C/W/Seg when these devices are soldered into minimum trace width PC boards. When installed in a PC board that provides $R\theta_{PIN\text{-}A}$ less than 400° C/W/Seg these displays may be operated at higher average currents as shown in Figure 2.

## Optical

The radiation pattern for these devices is approximately Lambertian. The luminous sterance may be calculated using one of the two following formulas.

$$L_V(\text{cd/m}^2) = \frac{I_V(\text{cd})}{A(\text{m}^2)}$$

$$L_V(\text{footlamberts}) = \frac{\pi I_V(\text{cd})}{A(\text{ft}^2)}$$

| DEVICE | AREA/SEG. mm$^2$ | AREA/SEG. IN.$^2$ |
|---|---|---|
| -3530/-4030 | 2.5 | .0039 |
| -3730/-4130 | 4.4 | .0068 |
| -5530/-5730 | 8.8 | .0137 |
| -3900/-4200 | 14.9 | .0231 |

## Contrast Enhancement

The objective of contrast enhancement is to optimize display readability. Adequate contrast enhancement can be achieved in indoor applications through luminous contrast techniques. Luminous contrast is the observed brightness of the illuminated segment compared to the brightness of the surround. Appropriate wavelength filters maximize luminous contrast by reducing the amount of light reflected from the area around the display while transmitting most of the light emitted by the segment. These filters are described further in Application Note 964.

Chrominance contrast can further improve display readability. Chrominance contrast refers to the color difference between the illuminated segment and the surrounding area. These displays are assembled with a gray package and untinted encapsulating epoxy in the segments to improve chrominance contrast of the ON segments. Additional contrast enhancement in bright ambients may be achieved by using a neutral density gray filter such as Panelgraphic Chromafilter Gray 10, or 3M Light Control Film (louvered film).

HEWLETT PACKARD

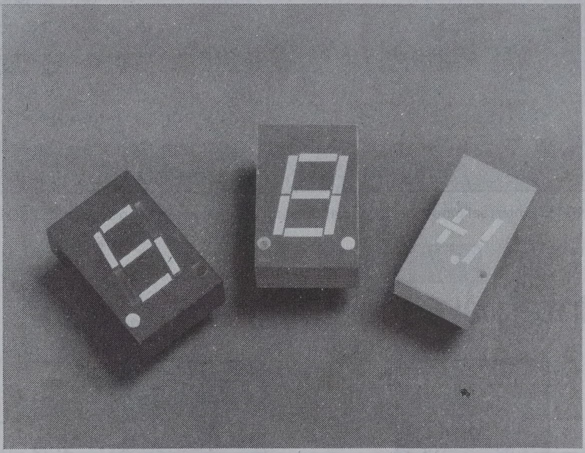
# 7.6/10.9 mm (0.3/0.43 INCH) SEVEN SEGMENT DISPLAYS

HIGH EFFICIENCY RED • 5082-7610/-7650 SERIES
YELLOW • 5082-7620/-7660 SERIES
GREEN • 5082-7630/-7670 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **COMPACT SIZE**
- **CHOICE OF 3 BRIGHT COLORS**
  - High Efficiency Red
  - Yellow
  - Green
- **LOW CURRENT OPERATION**
  - As Low as 3mA per Segment
  - Designed for Multiplex Operation
- **EXCELLENT CHARACTER APPEARANCE**
  - Evenly Lighted Segments
  - Wide Viewing Angle
  - Body Color Improves "Off" Segment Contrast
- **EASY MOUNTING ON PC BOARD OR SOCKETS**
  - Industry Standard 7.62mm (.3 in.) DIP Leads on 2.54mm (.1 in.) Centers
- **CATEGORIZED FOR LUMINOUS INTENSITY; YELLOW AND GREEN CATEGORIZED FOR COLOR**
  - Use of Like Categories Yields a Uniform Display
- **IC COMPATIBLE**
- **MECHANICALLY RUGGED**



## Description

The 5082-7610/-7620/-7630 and -7650/-7660/-7670 series are 7.62/10.92 mm (0.3/0.43 in) high efficiency red, yellow and green displays. The 5082-7610/-7620/-7630 series displays are designed for viewing distances of up to three meters and the 5082-7650/-7660/-7670 series displays are designed for viewing distances of up to six meters. These displays are designed for use in instruments, point of sale terminals, clocks, and appliances. The 5082-7610/-7620/-7650/-7660 series devices utilize high efficiency chips which are made from GaAsP on a transparent GaP substrate. The 5082-7630/-7670 series devices utilize chips made from GaP on a transparent GaP substrate.

## Devices

| Part No. 5082- | Color | Description | Package Drawing |
|---|---|---|---|
| 7610 | High Efficiency Red | 7.6 mm Common Anode Left Hand Decimal | A |
| 7611 | High Efficiency Red | 7.6 mm Common Anode Right Hand Decimal | B |
| 7613 | High Efficiency Red | 7.6 mm Common Cathode Right Hand Decimal | C |
| 7616 | High Efficiency Red | 7.6 mm Universal Overflow ±1 Right Hand Decimal | D |
| 7620 | Yellow | 7.6 mm Common Anode Left Hand Decimal | A |
| 7621 | Yellow | 7.6 mm Common Anode Right Hand Decimal | B |
| 7623 | Yellow | 7.6 mm Common Cathode Right Hand Decimal | C |
| 7626 | Yellow | 7.6 mm Universal Overflow ±1 Right Hand Decimal | D |
| 7630 | Green | 7.6 mm Common Anode Left Hand Decimal | A |
| 7631 | Green | 7.6 mm Common Anode Right Hand Decimal | B |
| 7633 | Green | 7.6 mm Common Cathode Right Hand Decimal | C |
| 7636 | Green | 7.6 mm Universal Overflow ±1 Right Hand Decimal | D |

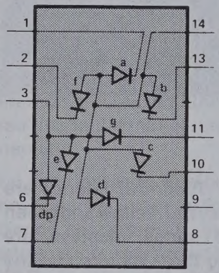
NOTE: Universal pinout brings the anode and cathode of each segment's LED out to separate pins. See internal diagram D.

## Devices

| Part No. 5082- | Color | Description | Package Drawing |
|---|---|---|---|
| 7650 | High Efficiency Red | 10.9 mm Common Anode Left Hand Decimal | E |
| 7651 | High Efficiency Red | 10.9 mm Common Anode Right Hand Decimal | F |
| 7653 | High Efficiency Red | 10.9 mm Common Cathode Right Hand Decimal | G |
| 7656 | High Efficiency Red | 10.9 mm Universal Overflow ±1 Right Hand Decimal | H |
| 7660 | Yellow | 10.9 mm Common Anode Left Hand Decimal | E |
| 7661 | Yellow | 10.9 mm Common Anode Right Hand Decimal | F |
| 7663 | Yellow | 10.9 mm Common Cathode Right Hand Decimal | G |
| 7666 | Yellow | 10.9 mm Universal Overflow ±1 Right Hand Decimal | H |
| 7670 | Green | 10.9 mm Common Anode Left Hand Decimal | E |
| 7671 | Green | 10.9 mm Common Anode Right Hand Decimal | F |
| 7673 | Green | 10.9 mm Common Cathode Right Hand Decimal | G |
| 7676 | Green | 10.9 mm Universal Overflow ±1 Right Hand Decimal | H |

NOTE: Universal pinout brings the anode and the cathode of each segment's LED out to separate pins, see internal diagram H.

## Internal Circuit Diagram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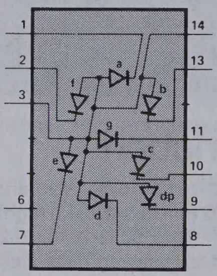
A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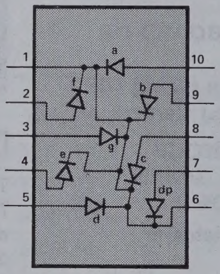
B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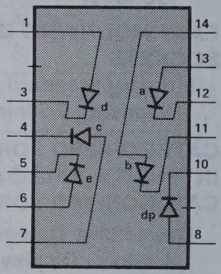
C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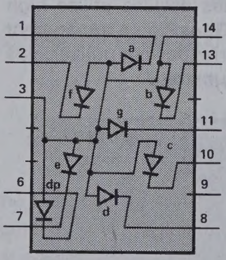
D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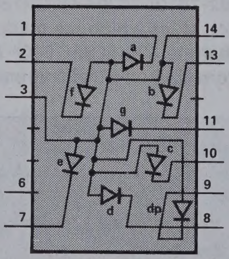
f
g
dp

E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f
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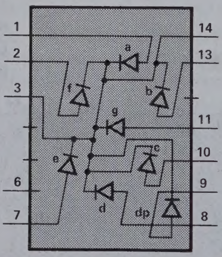
dp

F


1
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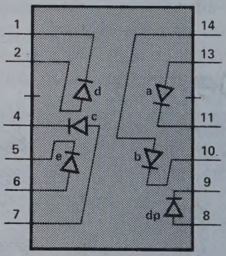
dp

G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d
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dp

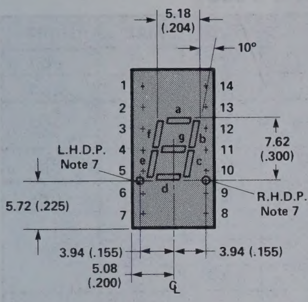
H

## Absolute Maximum Ratings

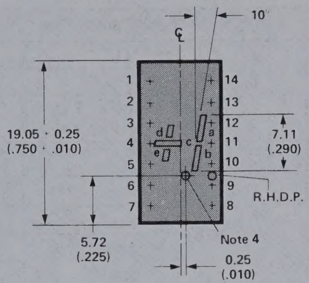
| | |
|---|---|
| Average Power Dissipation Per Segment or D.P.[1] ($T_A$)=50° C) | 81mW |
| Operating Temperature Range | -40° C to +85° C |
| Storage Temperature Range | -40° C to +85° C |
| Peak Forward Current Per Segment or D.P(3) ($T_A$=50° C) | 60mA |
| DC Forward Current Per Segment or D.P.(1,2) ($T_A$=50° C) | 20mA |
| Reverse Voltage Per Segment or D.P. | 6.0V |
| Lead Soldering Temperature | 260° C for 3 Sec [1.59mm (1/16 inch) below seating plane(4)] |

Notes: 1. See power derating curve (Fig.2). 2. Derate average current from 50° C at 0.4mA/° C per segment. 3. See Maximum Tolerable Segment Peak Current vs. Pulse Duration curve, (Fig. 1). 4. Clean only in water, isopropanol, ethanol, Freon TF or TE (or equivalent) and Genesolv DI-15 or DE-15 (or equivalent).

# Package Dimensions (5082-7610/-7620/-7630)

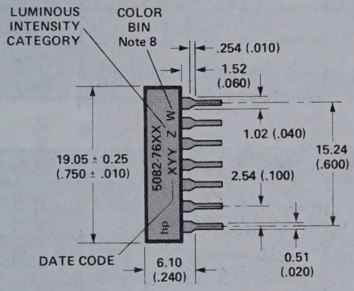

5.18
(.204)
10°
1
2
3
4
5
6
7
14
13
12
11
10
9
8
a
f
g
b
e
c
d
L.H.D.P.
Note 7
7.62
(.300)
R.H.D.P.
Note 7
5.72 (.225)
3.94 (.155)
3.94 (.155)
5.08
(.200)
℄

A,B,C

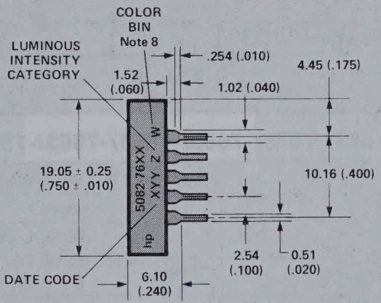

℄
10°
19.05 ± 0.25
(.750 ± .010)
7.11
(.290)
d
e
c
a
b
R.H.D.P.
Note 4
5.72
(.225)
0.25
(.010)

D

| PIN | FUNCTION<br>A<br>-7610/-7620/<br>-7630 | B<br>-7611/-7621/<br>-7631 | C<br>-7613/-7623/<br>-7633 | D<br>-7616/-7626/<br>-7636 |
|---|---|---|---|---|
| 1 | CATHODE-a | CATHODE-a | CATHODE[6] | ANODE-d |
| 2 | CATHODE-f | CATHODE-f | ANODE-f | NO PIN |
| 3 | ANODE[3] | ANODE[3] | ANODE-g | CATHODE-d |
| 4 | NO PIN | NO PIN | ANODE-e | CATHODE-c |
| 5 | NO PIN | NO PIN | ANODE-d | CATHODE-e |
| 6 | CATHODE-dp | NO CONN.[5] | CATHODE[6] | ANODE-e |
| 7 | CATHODE-e | CATHODE-e | ANODE-dp | ANODE-c |
| 8 | CATHODE-d | CATHODE-d | ANODE-c | ANODE-dp |
| 9 | NO CONN.[5] | CATHODE-dp | ANODE-b | NO PIN |
| 10 | CATHODE-c | CATHODE-c | ANODE-a | CATHODE-dp |
| 11 | CATHODE-g | CATHODE-g |  | CATHODE-b |
| 12 | NO PIN | NO PIN |  | CATHODE-a |
| 13 | CATHODE-b | CATHODE-b |  | ANODE-a |
| 14 | ANODE[3] | ANODE[3] |  | ANODE-b |


LUMINOUS
INTENSITY
CATEGORY
COLOR
BIN
Note 8
.254 (.010)
1.52
(.060)
1.02 (.040)
15.24
(.600)
19.05 ± 0.25
(.750 ± .010)
2.54 (.100)
5082-76XX
XYY Z
W
hp
DATE CODE
6.10
(.240)
0.51
(.020)

A,B,D
SIDE


COLOR
BIN
Note 8
LUMINOUS
INTENSITY
CATEGORY
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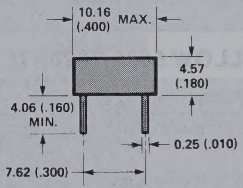
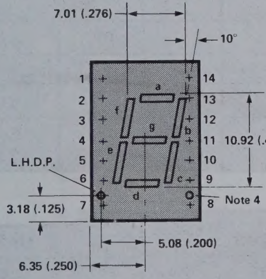
(.060)
1.02 (.040)
4.45 (.175)
19.05 ± 0.25
(.750 ± .010)
10.16 (.400)
5082-76XX
XYY Z
W
hp
DATE CODE
6.10
(.240)
2.54
(.100)
0.51
(.020)

C
SIDE


10.16
(.400)
MAX.
4.57
(.180)
4.06 (.160)
MIN.
0.25 (.010)
7.62 (.300)

A,B,C,D
END

## (5082-7650/-7660/-7670)


7.01 (.276)
10°
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14
13
12
11
10
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a
f
g
b
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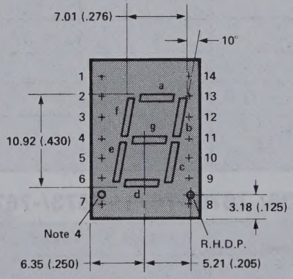
d
10.92 (.430)
L.H.D.P.
Note 4
3.18 (.125)
5.08 (.200)
6.35 (.250)

E


7.01 (.276)
10°
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a
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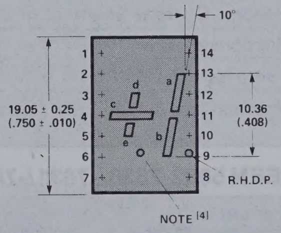
g
b
e
c
d
10.92 (.430)
3.18 (.125)
Note 4
R.H.D.P.
6.35 (.250)
5.21 (.205)

F,G
FRONT VIEW


10°
1
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12
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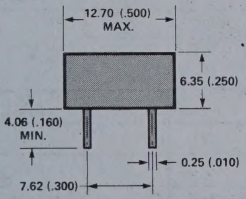
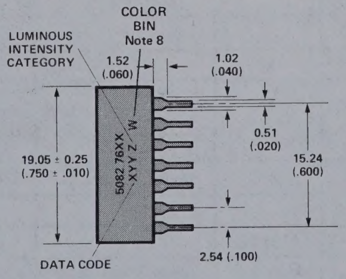
8
a
d
c
b
e
19.05 ± 0.25
(.750 ± .010)
10.36
(.408)
R.H.D.P.
NOTE [4]

H


12.70 (.500)
MAX.
6.35 (.250)
4.06 (.160)
MIN.
0.25 (.010)
7.62 (.300)

END VIEW


LUMINOUS
INTENSITY
CATEGORY
COLOR
BIN
Note 8
1.52
(.060)
1.02
(.040)
0.51
(.020)
19.05 ± 0.25
(.750 ± .010)
15.24
(.600)
5082 76XX
XYY Z
W
DATA CODE
2.54 (.100)

SIDE VIEW

| PIN | FUNCTION<br>E<br>-7650/-7660/<br>-7670 | F<br>-7651/-7661/<br>-7671 | G<br>-7653/-7663/<br>-7673 | H<br>-7656/-7666/<br>-7676 |
|---|---|---|---|---|
| 1 | CATHODE-a | CATHODE-a | ANODE-a | CATHODE-d |
| 2 | CATHODE-f | CATHODE-f | ANODE-f | ANODE-d |
| 3 | ANODE[3] | ANODE[3] | CATHODE[6] | NO PIN |
| 4 | NO PIN | NO PIN | NO PIN | CATHODE-c |
| 5 | NO PIN | NO PIN | NO PIN | CATHODE-e |
| 6 | CATHODE-dp | NO CONN.[5] | NO CONN.[5] | ANODE-e |
| 7 | CATHODE-e | CATHODE-e | ANODE-e | ANODE-c |
| 8 | CATHODE-d | CATHODE-d | ANODE-d | ANODE-dp |
| 9 | NO CONN.[5] | CATHODE-dp | ANODE-dp | CATHODE-dp |
| 10 | CATHODE-c | CATHODE-c | ANODE-c | CATHODE-b |
| 11 | CATHODE-g | CATHODE-g | ANODE-g | CATHODE-a |
| 12 | NO PIN | NO PIN | NO PIN | NO PIN |
| 13 | CATHODE-b | CATHODE-b | ANODE-b | ANODE-a |
| 14 | ANODE[3] | ANODE[3] | CATHODE[6] | ANODE-b |

NOTES:

1. Dimensions in millimeters and (inches).
2. All untoleranced dimensions are for reference only
3. Redundant anodes.
4. Unused dp position.
5. See Internal Circuit Diagram.
6. Redundant cathode.
7. See part number table for L.H.D.P. and R.H.D.P. designation.
8. For 76201/-7660/-7630/-7670 Series Devices only.

# Electrical/Optical Characteristics at $T_A = 25°C$

## HIGH EFFICIENCY RED 5082-7610/-7611/-7613/-7616/-7650/-7651/-7653/-7656

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment [5,8]<br>(Digit Average) | $I_v$ | 5mA D.C. | 200 | 550 | | μcd |
| | | 20mA D.C. | | 3025 | | μcd |
| | | 60mA Pk: 1 of 6 Duty Factor | | 1765 | | μcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 635 | | nm |
| Dominant Wavelength [6] | $\lambda_d$ | | | 626 | | nm |
| Forward Voltage/Segment or D.P. | $V_F$ | $I_F = 5mA$ | | 1.7 | | V |
| | | $I_F = 20mA$ | | 2.0 | 2.5 | |
| | | $I_F = 60mA$ | | 2.8 | | |
| Reverse Current/Segment or D.P. | $I_R$ | $V_R = 3V$ | | | 100 | μA |
| Response Time [8] | $t_r, t_f$ | | | 90 | | ns |
| Temperature Coefficient of $V_F$/Segment or D.P. | $\Delta V_F/°C$ | | | −2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 282 | | °C/W/Seg |

## YELLOW 5082-7620/-7621/-7623/-7626/-7660/-7661/-7663/-7666

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment [5,8]<br>(Digit Average) | $I_v$ | 5mA D.C. | 160 | 400 | | μcd |
| | | 20mA D.C. | | 2280 | | μcd |
| | | 60mA Pk: 1 of 6 Duty Factor | | 1440 | | μcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 583 | | nm |
| Dominant Wavelength [6,7] | $\lambda_d$ | | 581.5 | 586 | 592.5 | nm |
| Forward Voltage/Segment or D.P. | $V_F$ | $I_F = 5mA$ | | 1.8 | | V |
| | | $I_F = 20mA$ | | 2.2 | 2.5 | |
| | | $I_F = 60mA$ | | 3.1 | | |
| Reverse Current/Segment or D.P. | $I_R$ | $V_R = 3V$ | | | 100 | μA |
| Response Time [8] | $t_r, t_f$ | | | 90 | | ns |
| Temperature Coefficient of $V_F$/Segment or D.P. | $V_F/°C$ | | | −2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 282 | | °C/W/Seg |

## GREEN 5082-7630/-7631/-7633/-7636/-7670/-7671/-7673/-7676

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment [5,8]<br>(Digit Average) | $I_v$ | 10mA D.C. | 125 | 300 | | μcd |
| | | 20mA D.C. | | 780 | | μcd |
| | | 60mA Pk: 1 of 6 Duty Factor | | 540 | | μcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 565 | | nm |
| Dominant Wavelength [6,7] | $\lambda_d$ | | | 572 | | nm |
| Forward Voltage/Segment or D.P. | $V_F$ | $I_F = 5mA$ | | 1.9 | | V |
| | | $I_F = 20mA$ | | 2.2 | 2.5 | |
| | | $I_F = 60mA$ | | 2.9 | | |
| Reverse Current/Segment or D.P. | $I_F$ | $V_R = 3V$ | | | 100 | μA |
| Response Time [8] | $t_r, t_f$ | | | 90 | | ns |
| Temperature Coefficient of $V_F$/Segment or D.P. | $\Delta V_F/°C$ | | | −2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 282 | | °C/W/Seg |

NOTES:
5. The digits are categorized for luminous intensity with the intensity category designated by a letter located on the right hand side of the package.
6. The dominant wavelength, $\lambda_d$, is derived from the C.I.E. Chromaticity Diagram and is that single wavelength which defines the color of the device.
7. The 5082-7620/-7630/-7660/-7670 series yellow/green displays are categorized as to dominant wavelength with the category designated by a number adjacent to the intensity category letter.
8. Time for a 10% — 90% change of light intensity for step change in current.

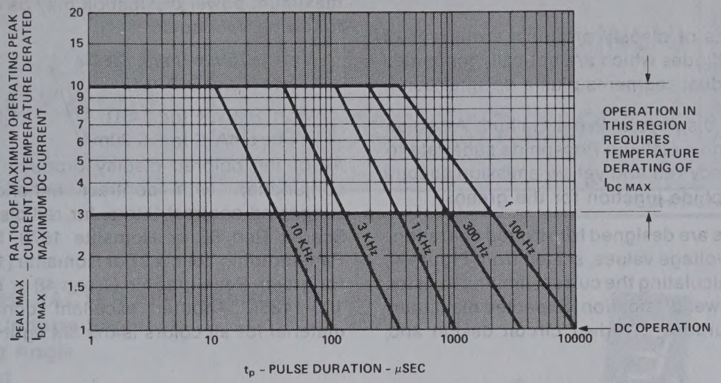


**Figure 1. Maximum Tolerable Peak Current vs. Pulse Duration**

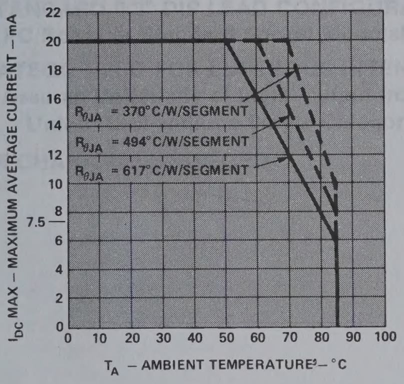


**Figure 2. Maximum Allowable DC Current and DC Power Dissipation per Segment as a Function of Ambient Temperature.**

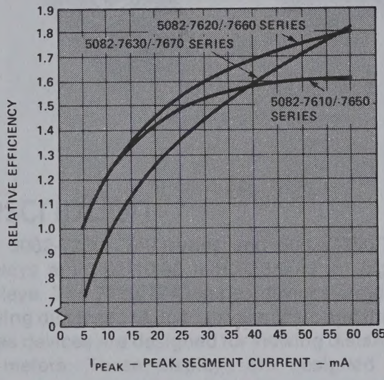


**Figure 3. Relative Luminous Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current.**

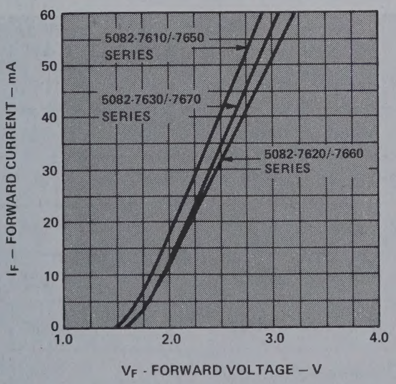


**Figure 4. Forward Current vs. Forward Voltage Characteristic.**

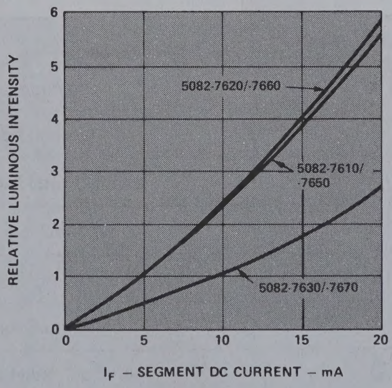


**Figure 5. Relative Luminous Intensity vs. DC Forward Current.**

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

ELECTRICAL

The 5082-7600 series of display products are arrays of eight light emitting diodes which are optically magnified to form seven individual segments plus a decimal point.

The diodes in these displays utilize a Gallium Arsenide Phosphide junction on a Gallium Phosphide substrate to produce high efficiency red and yellow emission spectra and a Gallium Phosphide junction for the green.

These display devices are designed for strobed operation. The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design and maximum power dissipation may be calculated using the following $V_F$ models.

$V_F = 1.75V + I_{PEAK}\ (38\Omega)$
For $I_{PEAK} \geq 20mA$

$V_F = 1.60V + I_{DC}\ (45\Omega)$
For $5mA \leq I_{DC} \leq 20mA$

All of the colored display products should be used in conjunction with contrast enhancing filters. Some suggested contrast filters: for red displays, Panelgraphic Scarlet Red 65 or Homalite 1670; for yellow displays, Panelgraphic Yellow 27 or Homalite (100-1720, 100-1726); for green, Panelgraphic Green 48 or Homalite (100-1440, 100-1425). Another excellent contrast enhancement material for all colors is the 3M light control film.

HEWLETT PACKARD

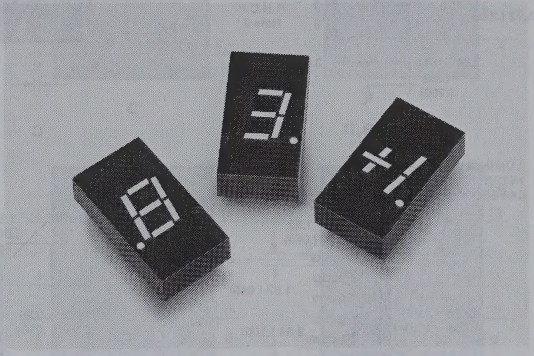
# 7.6/10.9mm (0.3/0.43 INCH) RED SEVEN SEGMENT DISPLAYS

**5082-7730 SERIES**
**5082-7740**
**5082-7750 SERIES**
**5082-7760**

TECHNICAL DATA FEBRUARY 1982

## Features

- **EXCELLENT CHARACTER APPEARANCE**
  - Continuous Uniform Segments
  - Wide Viewing Angle
  - High Contrast
- **IC COMPATIBLE**
  - 1.6V dc per Segment
- **STANDARD 0.3" DIP LEAD CONFIGURATION**
  - PC Board or Standard Socket Mountable
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  - Assures Uniformity of Light Output from Unit to Unit within a Single Category
- **MECHANICALLY RUGGED**



## Description

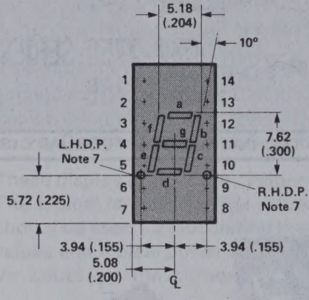
The 5082-7730/7740 series and 5082-7750/7760 series displays are 7.62/10.92 mm (0.3/0.43 in) high red LED displays. The 7730/7740 series devices are designed for viewing distances of up to three meters and the 7750/7760 series devices are designed for viewing distances of up to six meters. These displays are designed for use in instruments, point of sale terminals, clocks and appliances. These devices use LED die made with GaAsP on a GaAs substrate.

## Devices

| Part No. 5082- | Description | Package Drawing |
|---|---|---|
| 7730 | 7.6 mm Common Anode Left Hand Decimal | A |
| 7731 | 7.6 mm Common Anode Right Hand Decimal | B |
| 7736 | 7.6 mm Universal Overflow ±1 Right Hand Decimal | C |
| 7740 | 7.6 mm Common Cathode Right Hand Decimal | D |
| 7750 | 10.9 mm Common Anode Left Hand Decimal | E |
| 7751 | 10.9 mm Common Anode Right Hand Decimal | F |
| 7756 | 10.9 mm Universal Overflow ±1 Right Hand Decimal | G |
| 7760 | 10.9 mm Common Cathode Right Hand Decimal | H |

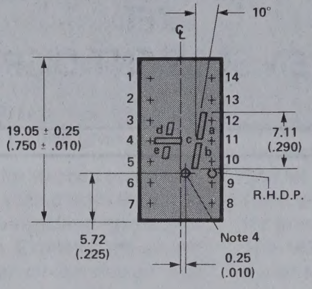
Note: Universal pinout brings the anode and cathode of each segment's LED out to separate pins. See internal diagram C, G.

# Package Dimensions 5082-7730/-7731/-7736/-7740



5.18
(.204)
10°
L.H.D.P.
Note 7
7.62
(.300)
R.H.D.P.
Note 7
5.72 (.225)
3.94 (.155)
3.94 (.155)
5.08
(.200)
℄
a
b
c
d
e
f
g
1
2
3
4
5
6
7
8
9
10
11
12
13
14

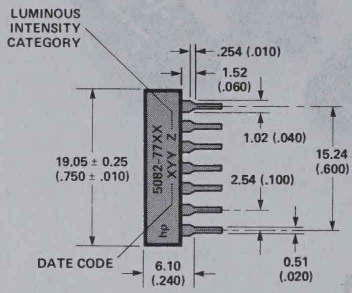
A,B,D



10°
℄
19.05 ± 0.25
(.750 ± .010)
7.11
(.290)
5.72
(.225)
R.H.D.P.
Note 4
0.25
(.010)
a
b
c
d
e
1
2
3
4
5
6
7
8
9
10
11
12
13
14

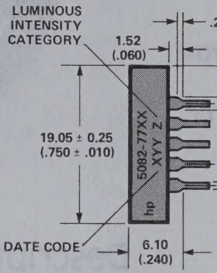
C

| PIN | FUNCTION<br>A<br>-7730 | <br>B<br>-7731 | <br>C<br>-7736 | <br>D<br>-7740 |
|---|---|---|---|---|
| 1 | CATHODE-a | CATHODE-a | ANODE-d | CATHODE[6] |
| 2 | CATHODE-f | CATHODE-f | NO PIN | ANODE-f |
| 3 | ANODE[3] | ANODE[3] | CATHODE-d | ANODE-g |
| 4 | NO PIN | NO PIN | CATHODE-c | ANODE-e |
| 5 | NO PIN | NO PIN | CATHODE-e | ANODE-d |
| 6 | CATHODE-dp | NO CONN.[5] | ANODE-e | CATHODE[6] |
| 7 | CATHODE-e | CATHODE-e | ANODE-c | ANODE-dp |
| 8 | CATHODE-d | CATHODE-d | ANODE-dp | ANODE-c |
| 9 | NO CONN.[5] | CATHODE-dp | NO PIN | ANODE-b |
| 10 | CATHODE-c | CATHODE-c | CATHODE-dp | ANODE-a |
| 11 | CATHODE-g | CATHODE-g | CATHODE-b | |
| 12 | NO PIN | NO PIN | CATHODE-a | |
| 13 | CATHODE-b | CATHODE-b | ANODE-a | |
| 14 | ANODE[3] | ANODE[3] | ANODE-b | |



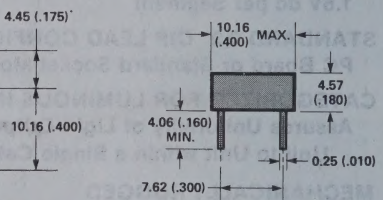
LUMINOUS
INTENSITY
CATEGORY
.254 (.010)
1.52
(.060)
1.02 (.040)
19.05 ± 0.25
(.750 ± .010)
2.54 (.100)
15.24
(.600)
5082-77XX
XYY Z
hp
DATE CODE
6.10
(.240)
0.51
(.020)

A,B,C
SIDE



LUMINOUS
INTENSITY
CATEGORY
.254 (.010)
1.52
(.060)
1.02 (.040)
19.05 ± 0.25
(.750 ± .010)
10.16 (.400)
5082-77XX
XYY Z
hp
2.54
(.100)
0.51
(.020)
DATE CODE
6.10
(.240)

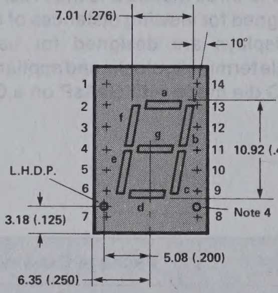
D
SIDE



4.45 (.175)
10.16
(.400)
MAX.
4.57
(.180)
4.06 (.160)
MIN.
0.25 (.010)
7.62 (.300)

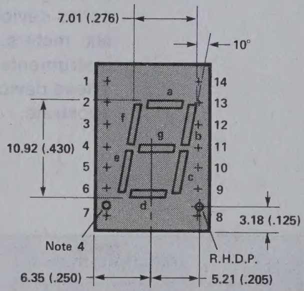
A,B,C,D
END

## 5082-7750/-7751/-7756/-7760



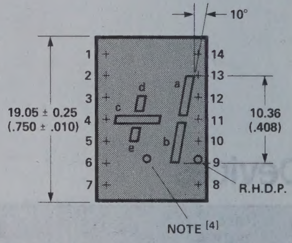
7.01 (.276)
10°
L.H.D.P.
10.92 (.430)
3.18 (.125)
Note 4
5.08 (.200)
6.35 (.250)
a
b
c
d
e
f
g
1
2
3
4
5
6
7
8
9
10
11
12
13
14

E



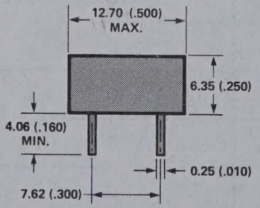
7.01 (.276)
10°
10.92 (.430)
3.18 (.125)
Note 4
R.H.D.P.
6.35 (.250)
5.21 (.205)
a
b
c
d
e
f
g
1
2
3
4
5
6
7
8
9
10
11
12
13
14

F,H
FRONT VIEW



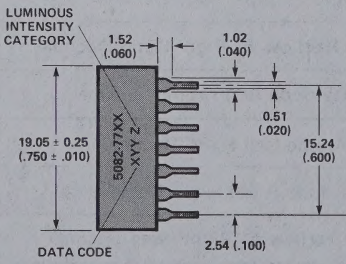
10°
19.05 ± 0.25
(.750 ± .010)
10.36
(.408)
R.H.D.P.
NOTE [4]
a
b
c
d
e
1
2
3
4
5
6
7
8
9
10
11
12
13
14

G



12.70 (.500)
MAX.
6.35 (.250)
4.06 (.160)
MIN.
0.25 (.010)
7.62 (.300)

END VIEW



LUMINOUS
INTENSITY
CATEGORY
1.52
(.060)
1.02
(.040)
0.51
(.020)
19.05 ± 0.25
(.750 ± .010)
15.24
(.600)
5082-77XX
XYY Z
DATE CODE
2.54 (.100)

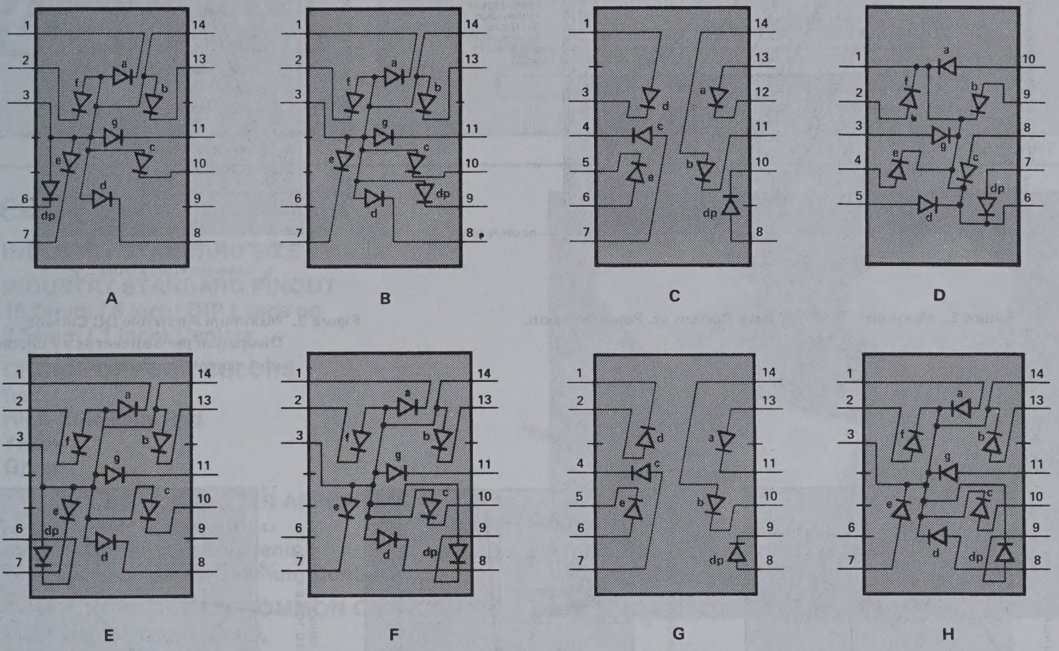
SIDE VIEW

| PIN | FUNCTION<br>E<br>-7750 | <br>F<br>-7751 | <br>G<br>-7756 | <br>H<br>-7760 |
|---|---|---|---|---|
| 1 | CATHODE-a | CATHODE-a | CATHODE-d | ANODE-a |
| 2 | CATHODE-f | CATHODE-f | ANODE-d | ANODE-f |
| 3 | ANODE[3] | ANODE[3] | NO PIN | CATHODE[6] |
| 4 | NO PIN | NO PIN | CATHODE-c | NO PIN |
| 5 | NO PIN | NO PIN | CATHODE-e | NO PIN |
| 6 | CATHODE-dp | NO CONN.[5] | ANODE-e | NO CONN.[5] |
| 7 | CATHODE-e | CATHODE-e | ANODE-c | ANODE-e |
| 8 | CATHODE-d | CATHODE-d | ANODE-dp | ANODE-d |
| 9 | NO CONN.[5] | CATHODE-dp | CATHODE-dp | ANODE-dp |
| 10 | CATHODE-c | CATHODE-c | CATHODE-b | ANODE-c |
| 11 | CATHODE-g | CATHODE-g | CATHODE-a | ANODE-g |
| 12 | NO PIN | NO PIN | NO PIN | NO PIN |
| 13 | CATHODE-b | CATHODE-b | ANODE-a | ANODE-b |
| 14 | ANODE[3] | ANODE[3] | ANODE-b | CATHODE[6] |

NOTES:

1. Dimensions in millimeters and (inches).
2. All untoleranced dimensions are for reference only
3. Redundant anodes.
4. Unused dp position.
5. See Internal Circuit Diagram.
6. Redundant cathode.
7. See part number table for L.H.D.P. and R.H.D.P. designation.

# Internal Circuit Diagram



# Absolute Maximum Ratings

Average Power Dissipation Per Segment or D.P.[1] ($T_A$=50°C) ............ 65mW
Operating Temperature Range .............................. -40°C to +85°C
Storage Temperature Range .............................. -40°C to +85°C
Peak Forward Current Per Segment or D.P.[3] ($T_A$=50°C) .................. 150mA
Average Forward Current Per Segment or D.P.[1,2] ($T_A$=50°C) ............... 25mA
Reverse Voltage Per Segment or D.P. ...................................... 6.0V
Lead Soldering Temperature .............................. 260°C for 3 Sec
[1.59mm (1/16 inch) below seating plane[4] ]

Notes: 1. See power derating curve (Fig.2). 2. Derate DC current from 50°C at 0.43mA/°C per segment. 3. See Fig. 1 to establish pulsed operating conditions. 4. Clean only in water, isopropanol, ethanol, Freon TF or TE (or equivalent) and Genesolv DI-15 or DE-15 (or equivalent).

# Electrical/Optical Characteristics at $T_A$=25°C

| Description | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment [2] (Digit Average) | $I_V$ | $I_{PEAK}$ = 100mA 10% Duty Cycle | | 610 | | μcd |
| | | $I_F$ = 20mA | 240 | 700 | | |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 655 | | nm |
| Dominant Wavelength [2] | $\lambda_d$ | | | 640 | | nm |
| Forward Voltage, any Segment or D.P. | $V_F$ | $I_F$ = 20mA | | 1.6 | 2.0 | V |
| Reverse Current, any Segment or D.P. | $I_R$ | $V_R$ = 3V | | | 100 | μA |
| Rise and Fall Time [3] | $t_r, t_f$ | | | 10 | | ns |
| Temperature Coefficient of Forward Voltage | $\Delta V_F$/°C | | | −2.0 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 282 | | °C/W/ Seg |

Notes:
1. The digits are categorized for luminous intensity with the intensity category designated by a letter located on the right hand side of the package.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE Chromaticity Diagram and is that single wavelength which defines the color of the device.
3. Time for a 10% - 90% change of light intensity for step change in current.

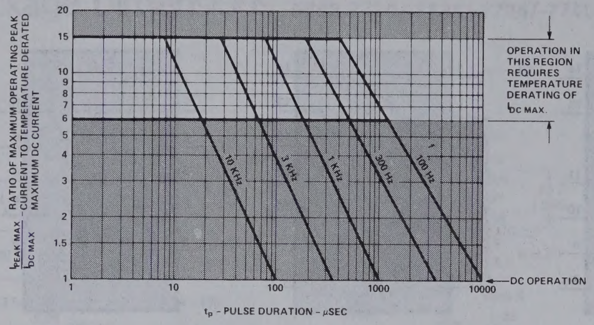


Figure 1. Maximum Tolerable Peak Current vs. Pulse Duration.

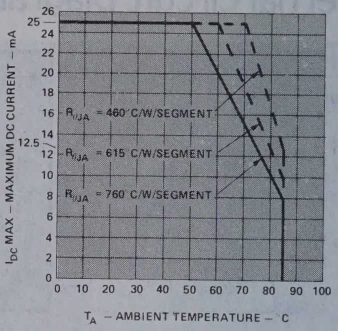


Figure 2. Maximum Allowable DC Current Dissipation per Segment as a Function of Ambient Temperature.

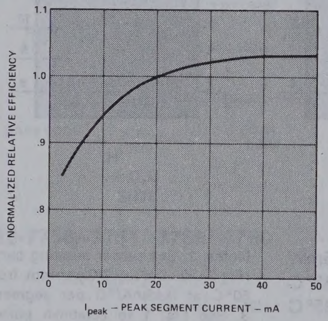


Figure 3. Relative Efficiency (Luminous Intensity per Unit Current) versus Peak Current per Segment.

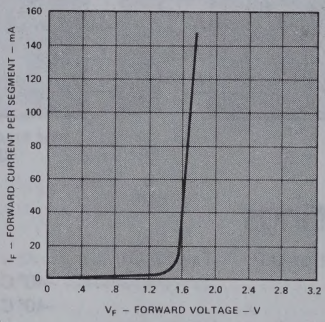


Figure 4. Forward Current vs. Forward Voltage.

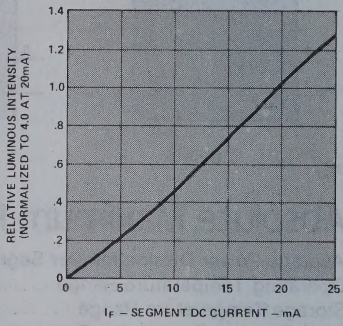


Figure 5. Relative Luminous Intensity vs. DC Forward Current

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

ELECTRICAL 5082-77XX

The 5082-77XX series of display devices are composed of eight light emitting diodes, with the light from each LED optically stretched to form individual segments and a decimal point. The LEDs have the P-N junction diffused into a GaAsP epitaxial layer on a GaAs substrate.

These display devices are designed for strobed operation at high peak currents. The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design may be calculated using the following $V_F$ model:

$$V_F = 1.55\text{V} + I_{PEAK}\ (7\Omega)$$
$$\text{For } 5\text{mA} \leq I_{PEAK} \leq 150\text{mA}$$

CONTRAST ENHANCEMENT

The 5082-77XX series display may be effectively filtered using one of the following filter products: Homalite H100-1605: H 100-1804 (purple); Panelgraphic Ruby Red 60: Dark Red 63: Purple 90; Plexiglas 2423; 3M Brand Light Control Film for daylight viewing.

**HEWLETT PACKARD**

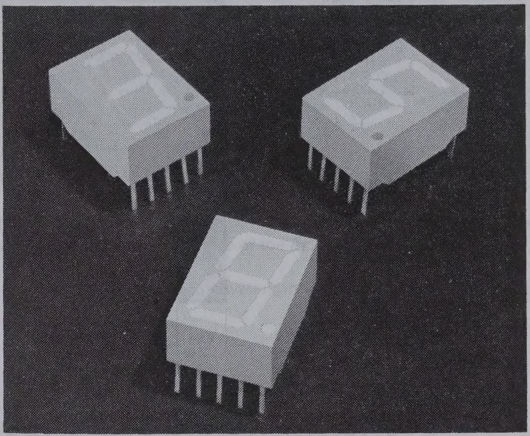
# 14.2mm (.56 INCH) SEVEN SEGMENT DISPLAYS

## RED HDSP-5300 SERIES
## HIGH EFFICIENCY RED HDSP-5500 SERIES
## YELLOW HDSP-5700 SERIES
## GREEN HDSP-5800 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **INDUSTRY STANDARD SIZE**
- **INDUSTRY STANDARD PINOUT**
  **15.24mm (.6 inch) DIP Leads on 2.54mm (.1 inch) Centers**
- **CHOICE OF FOUR COLORS**
  **Red**
  **High-Efficiency Red**
  **Yellow**
  **Green**
- **EXCELLENT CHARACTER APPEARANCE**
  **Evenly Lighted Segments**
  **Mitered Corners on Segments**
  **Gray Package Gives Optimum Contrast**
- **COMMON ANODE OR COMMON CATHODE**
  **Right Hand Decimal Point**
  **Overflow ±1 Character**
- **CATEGORIZED FOR LUMINOUS INTENSITY; YELLOW AND GREEN CATEGORIZED FOR COLOR**
  **Use of Like Categories Yields a Uniform Display**



## Description

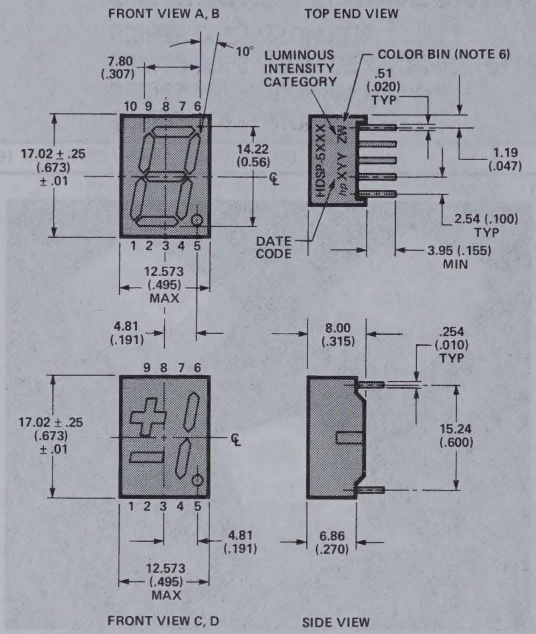
The HDSP-5300/-5500/-5700/-5800 Series are large 14.22mm (.56 inch) LED seven segment displays. Designed for viewing distances up to 7 metres (23 feet), these single digit displays provide excellent readability in bright ambients.

These devices utilize an industry standard size package and pin function configuration. Both the numeric and ±1 overflow devices feature a right hand decimal point and are available as either common anode or common cathode.

## Devices

| Part No. HDSP | Color | Description | Package Drawing |
|---|---|---|---|
| 5301 | Red | Common Anode Right Hand Decimal | A |
| 5303 | | Common Cathode Right Hand Decimal | B |
| 5307 | | Overflow ±1 Common Anode | C |
| 5308 | | Overflow ±1 Common Cathode | D |
| 5501 | High Efficiency Red | Common Anode Right Hand Decimal | A |
| 5503 | | Common Cathode Right Hand Decimal | B |
| 5507 | | Overflow ±1 Common Anode | C |
| 5508 | | Overflow ±1 Common Cathode | D |
| 5701 | Yellow | Common Anode Right Hand Decimal | A |
| 5703 | | Common Cathode Right Hand Decimal | B |
| 5707 | | Overflow ±1 Common Anode | C |
| 5708 | | Overflow ±1 Common Cathode | D |
| 5801 | Green | Common Anode Right Hand Decimal | A |
| 5803 | | Common Cathode Right Hand Decimal | B |
| 5807 | | Overflow ±1 Common Anode | C |
| 5808 | | Overflow ±1 Common Cathode | D |

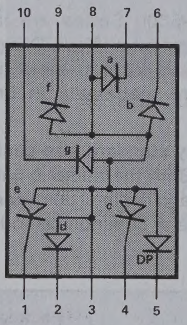
# Package Dimensions


FRONT VIEW A, B
TOP END VIEW
10°
7.80 (.307)
LUMINOUS INTENSITY CATEGORY
COLOR BIN (NOTE 6)
.51 (.020) TYP
10 9 8 7 6
17.02 ± .25 (.673) ± .01
14.22 (0.56)
℄
HDSP-5XXX
hp XYY ZW
1.19 (.047)
2.54 (.100) TYP
DATE CODE
1 2 3 4 5
12.573 (.495) MAX
3.95 (.155) MIN
4.81 (.191)
8.00 (.315)
.254 (.010) TYP
9 8 7 6
17.02 ± .25 (.673) ± .01
℄
15.24 (.600)
1 2 3 4 5
4.81 (.191)
6.86 (.270)
12.573 (.495) MAX
FRONT VIEW C, D
SIDE VIEW

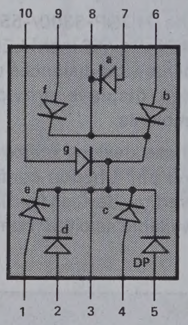
| PIN | FUNCTION | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 1 | CATHODE e | ANODE e | CATHODE c | ANODE c |
| 2 | CATHODE d | ANODE d | ANODE c, d | CATHODE c, d |
| 3 | ANODE(3) | CATHODE(4) | CATHODE b | ANODE b |
| 4 | CATHODE c | ANODE c | ANODE a, b DP | CATHODE a, b, DP |
| 5 | CATHODE DP | ANODE DP | CATHODE DP | ANODE DP |
| 6 | CATHODE b | ANODE b | CATHODE a | ANODE a |
| 7 | CATHODE a | ANODE a | ANODE a, b, DP | CATHODE a, b, DP |
| 8 | ANODE(3) | CATHODE(4) | ANODE c, d | CATHODE c, d |
| 9 | CATHODE f | ANODE f | CATHODE d | ANODE d |
| 10 | CATHODE g | ANODE g | NO PIN(5) | NO PIN(5) |

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES (INCHES).
2. ALL UNTOLERANCED DIMENSIONS ARE FOR REFERENCE ONLY.
3. REDUNDANT ANODES.
4. REDUNDANT CATHODES.
5. SEE INTERNAL CIRCUIT DIAGRAM.
6. FOR HDSP-5700/-5800 SERIES PRODUCT ONLY.

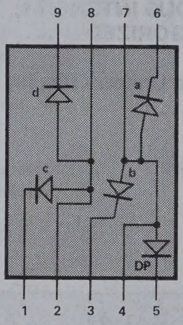
# Internal Circuit Diagram


10 9 8 7 6
a
f
b
g
e
c
d
DP
1 2 3 4 5

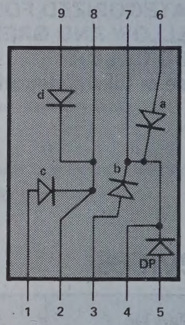
A


10 9 8 7 6
a
f
b
g
e
c
d
DP
1 2 3 4 5

B


9 8 7 6
d
a
c
b
DP
1 2 3 4 5

C


9 8 7 6
d
a
c
b
DP
1 2 3 4 5

D

# Absolute Maximum Ratings

| | -5300 Series | -5500/-5700<br>-5800 Series |
|---|---|---|
| Average Power per Segment or DP ($T_A = 50°C$) | 65 mW | 81 mW |
| Peak Forward Current per Segment or DP ($T_A = 50°C$) | 150 mA[7]<br>(Pulse Width = 1.25 ms) | 60 mA[8]<br>(Pulse Width = 2ms) |
| DC Forward Current per Segment[9] or DP ($T_A = 50°C$) | 25 mA | 20 mA |
| Operating Temperature Range | -40°C to +85°C | -40°C to +85°C |
| Storage Temperature Range | -40°C to +85°C | -40°C to +85°C |
| Reverse Voltage per Segment or DP | 6.0 V | 6.0 V |
| Lead Solder Temperature | 260°C for 3 sec. | 260°C for 3 sec. |

(1.59 mm [1/16 in.] below seating plane)

Notes:
7. See Figure 1 to establish pulsed operating conditions.
8. See Figure 6 to establish pulsed operating conditions.
9. Derate maximum DC current above $T_A = 50°C$:
at 0.43 mA/°C per segment for -5300 Series, see Figure 2.
at 0.40 mA/°C per segment for -5500/-5700/-5800, see Figure 7.

# Electrical/Optical Characteristics at $T_A = 25°C$

## RED HDSP-5300 SERIES

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment[10]<br>(Digit Average) | $I_V$ | $I_F = 20$ mA | 400 | 900 | | $\mu$cd |
| | | 100 mA Peak:<br>1 of 5 Duty Factor | | 925 | | |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 655 | | nm |
| Dominant Wavelength[11] | $\lambda_d$ | | | 640 | | nm |
| Forward Voltage/Segment or DP | $V_F$ | $I_F = 20$ mA | | 1.6 | 2.0 | V |
| Reverse Current/Segment or DP | $I_R$ | $V_R = 3V$ | | | 100 | $\mu$A |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 345 | | °C/W/ Seg |

Notes:

10. The digits are categorized for luminous intensity with category designated by a letter located on the right hand side of the package. The luminous intensity minimum and categories are determined by computing the numerical average of the individual segment intensities, decimal point not included.
11. The dominant wavelength, $\lambda_d$, is derived from the C.I.E. Chromaticity Diagram and is that single wavelength which defines the color of the device.

# Electrical

The HDSP-5300/-5500/-5700/-5800 series of display devices are composed of eight light emitting diodes, with the light from each LED optically stretched to form individual segments and a decimal point. The -5300 series use a p-n junction diffused into a GaAsP epitaxial layer on a GaAs substrate. The -5500 and -5700 series have their p-n junctions diffused into a GaAsP epitaxial layer on a GaP substrate. The -5800 series use a GaP epitaxial layer on GaP.

These display devices are designed for strobed operation. The typical forward voltage values, scaled from Figure 4 or 7, should be used for calculating the current limiting resistor value and typical power dissipation. Expected maximum $V_F$ values, for the purpose of driver circuit design and maximum power dissipation, may be calculated using the following $V_F$ MAX models:

HDSP-5300 Series:
$V_F \text{ MAX} = 1.55V + I_{PEAK}(7\Omega)$
For: $I_{PEAK} \geq 5$ mA

HDSP-5500/-5700/-5800 Series:
$V_F \text{ MAX} = 1.75V + I_{PEAK}(38\Omega)$
For: $I_{PEAK} \geq 20$ mA

$V_F \text{ MAX} = 1.6V + I_{DC}(45\Omega)$
For: $5 \text{ mA} \leq I_{DC} \leq 20$ mA

# Contrast Enhancement

The objective of contrast enhancement is to provide good display readability in the end use ambient light. The concept is to employ both luminance and chrominance contrast techniques to enhance readability by having the OFF-segments blend into the display background and have the ON-segments stand out vividly against this same background. Therefore, these display devices are assembled with a gray package and matching encapsulating epoxy in the segments.

Contrast enhancement may be achieved by using one of the following suggested filters:

| | |
|---|---|
| HDSP-5300: | Panelgraphic RUBY RED 60<br>SGL Homalite H100-1605 RED<br>3M Louvered Filter R6610 RED or N0210 GRAY |
| HDSP-5500: | Panelgraphic SCARLET RED 65 or GRAY 10<br>SGL Homalite H100-1670 RED or -1266 GRAY<br>3M Louvered Filter R6310 RED or N0210 GRAY |
| HDSP-5700: | Panelgraphic YELLOW 27 or GRAY 10<br>SGL Homalite H100-1720 AMBER or -1266 GRAY<br>3M Louvered Filter A5910 AMBER or N0210 GRAY |
| HDSP-5800: | Panelgraphic GREEN 48<br>SGL Homalite H100-1440 GREEN<br>3M Louvered Filter G5610 GREEN or N0210 GRAY |

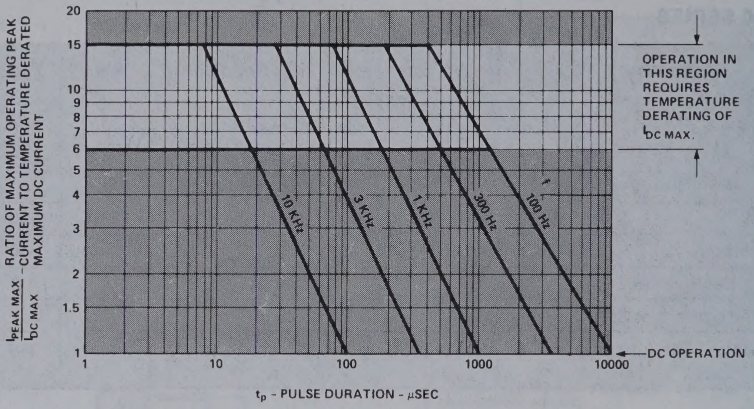


**Figure 1. Maximum Tolerable Peak Current vs. Pulse Duration.**

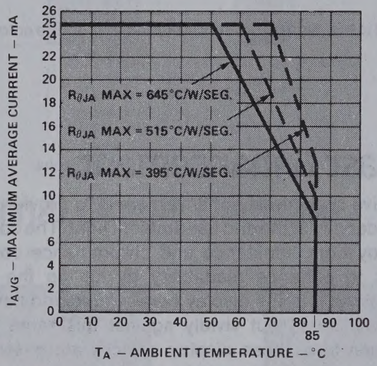


**Figure 2. Maximum Allowable Average Forward Current Per Segment vs. Ambient Temperature. Deratings Based on Maximum Allowed Thermal Resistance Values, LED Junction to Ambient on a per Segment Basis. $T_J$ MAX = 100°C.**

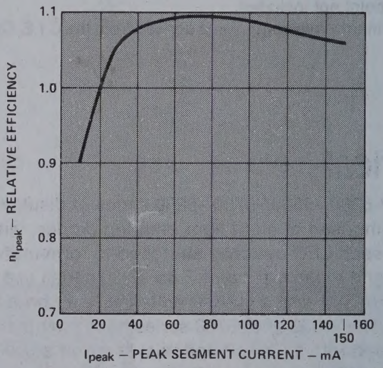


**Figure 3. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current.**

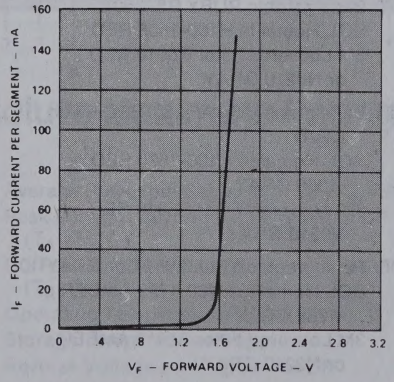


**Figure 4. Forward Current vs. Forward Voltage.**

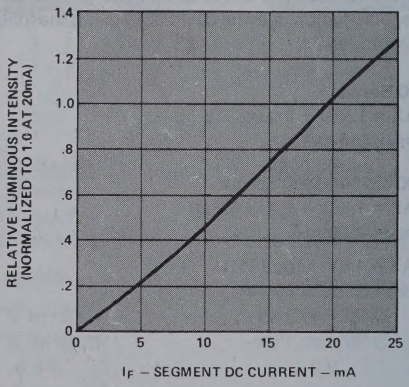


**Figure 5. Relative Luminous Intensity vs. D.C. Forward Current.**

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

## HIGH EFFICIENCY RED HDSP-5500 SERIES

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment[10] (Digit Average) | $I_V$ | 10 mA DC | 600 | 2000 | | μcd |
| | | 60 mA Peak: 1 of 6 Duty Factor | | 2700 | | |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 635 | | nm |
| Dominant Wavelength[11] | $\lambda_d$ | | | 626 | | nm |
| Forward Voltage/Segment or DP | $V_F$ | $I_F = 20$ mA | | 2.1 | 2.5 | V |
| Reverse Current/Segment or DP | $I_R$ | $V_R = 3$V | | | 100 | μA |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 345 | | °C/W/ Seg |

## YELLOW HDSP-5700 SERIES

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment[10] (Digit Average) | $I_V$ | 10 mA DC | 600 | 1500 | | μcd |
| | | 60 mA Peak: 1 of 6 Duty Factor | | 2180 | | |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 583 | | nm |
| Dominant Wavelength[11,12] | $\lambda_d$ | | 581.5 | 586 | 592.5 | nm |
| Forward Voltage/Segment or DP | $V_F$ | $I_F = 20$ mA | | 2.2 | 2.5 | V |
| Reverse Current/Segment or DP | $I_R$ | $V_R = 3$V | | | 100 | μA |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 345 | | °C/W/ Seg |

## GREEN HDSP-5800 SERIES

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment[10] (Digit Average) | $I_V$ | 20 mA DC | 400 | 600 | | μcd |
| | | 60 mA Peak: 1 of 3 Duty Factor | | 900 | | |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 565 | | nm |
| Dominant Wavelength[11,12] | $\lambda_d$ | | | 572 | | nm |
| Forward Voltage/Segment or DP | $V_F$ | $I_F = 20$ mA | | 2.2 | 2.5 | V |
| Reverse Current/Segment or DP | $I_R$ | $V_R = 3$V | | | 100 | μA |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 345 | | °C/W/ Seg |

Notes:

10. The digits are categorized for luminous intensity with category designated by a letter located on the right hand side of the package. The luminous intensity minimum and categories are determined by computing the numerical average of the individual segment intensities, decimal point not included.
11. The dominant wavelength, $\lambda_d$, is derived from the C.I.E. Chromaticity Diagram and is that single wavelength which defines the color of the device.
12. The HDSP-5700/-5800 series yellow/green displays are categorized as to dominant wavelength with the category designated by a number adjacent to the intensity category letter.

## HDSP-5500/-5700/-5800 SERIES

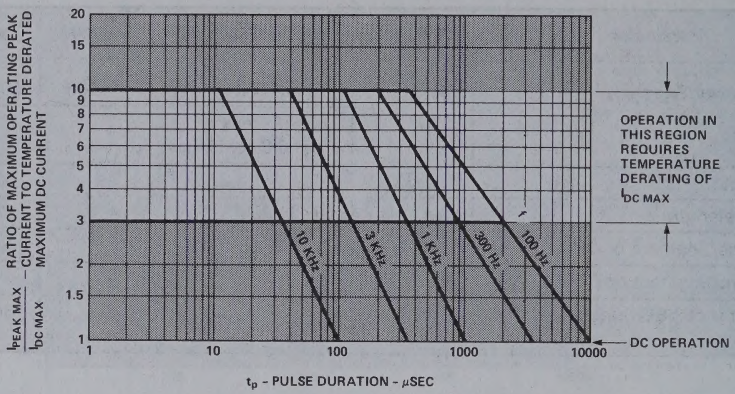


**Figure 6. Maximum Tolerable Peak Current vs. Pulse Duration.**

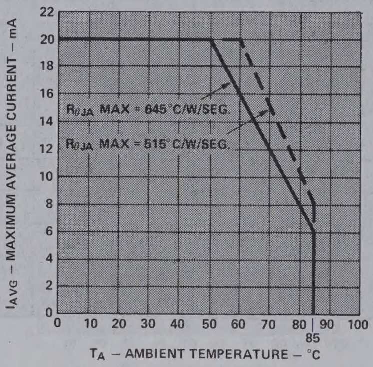


**Figure 7. Maximum Allowable Average Current per Segment vs. Ambient Temperature. Derating Based on Maximum Allowed Thermal Resistance Values, LED Junction to Ambient on a per Segment Basis. $T_J$ LED MAX = 100°C**

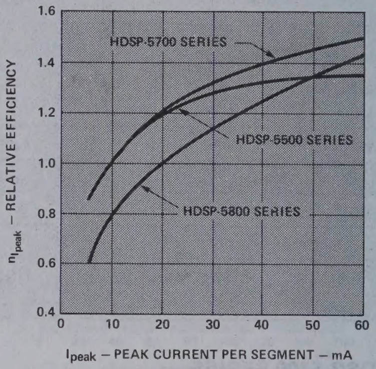


**Figure 8. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current.**

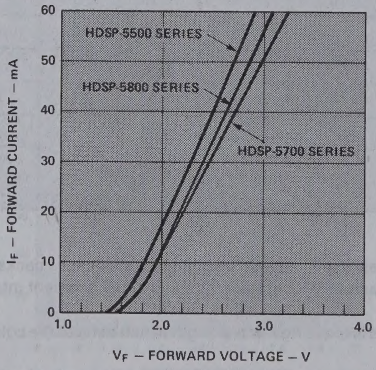


**Figure 9. Forward Current vs. Forward Voltage Characteristics.**

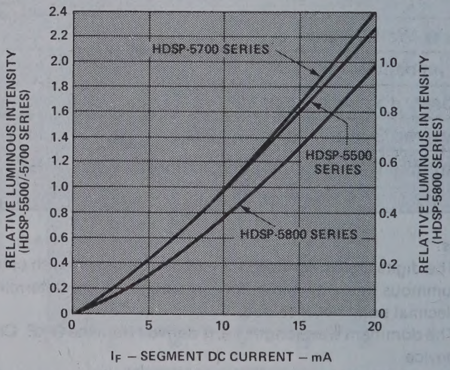


**Figure 10. Relative Luminous Intensity vs. DC Forward Current.**

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

HEWLETT PACKARD

# 20mm (0.8") RED SEVEN SEGMENT DISPLAY

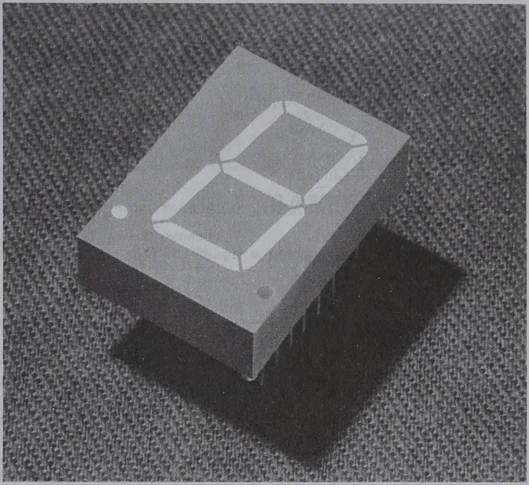
# HDSP-3400 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **20mm (0.8") DIGIT HEIGHT**
  **Viewing Up to 10 Metres (33 Feet)**
- **EXCELLENT CHARACTER APPEARANCE**
  **Excellent Readability in Bright Ambients Through Superior Contrast Enhancement**
  - **— Gray Body Color**
  - **— Untinted Segments**

  **Wide Viewing Angle**
  **Evenly Lighted Segments**
  **Mitered Corners on Segments**
- **LOW POWER REQUIREMENTS**
  **Single GaAsP Chip per Segment**
- **EASY MOUNTING ON PC BOARD OR SOCKETS**
  **Industry Standard 15.24mm (0.6") DIP with Lead Spacing on 2.54mm (0.1") Centers**
  **Industry Standard Package Dimensions and Pinouts**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  **Assures Uniformity of Light Output from Unit to Unit Within a Single Category**
- **IC COMPATIBLE**
- **MECHANICALLY RUGGED**



## Description

The HDSP-3400 Series are very large 20.32mm (0.8 in.) GaAsP LED seven segment displays. Designed for viewing distances up to 10 metres (33 feet), these single digit displays provide excellent readability in bright ambients.

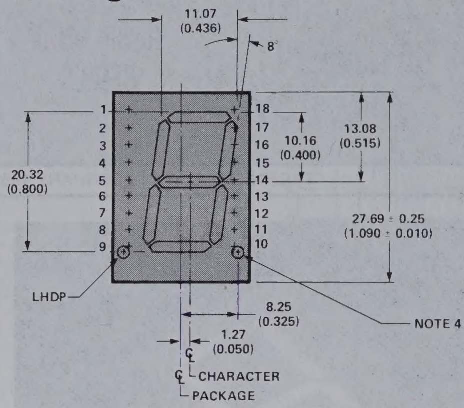
These devices utilize a standard 15.24mm (0.6 in.) dual in line package configuration that permits mounting on PC boards or in standard IC sockets. Requiring a low forward voltage, these displays are inherently IC compatible, allowing for easy integration into electronic instrumentation, point-of-sale terminals, TVs, weighing scales, and digital clocks.

## Devices

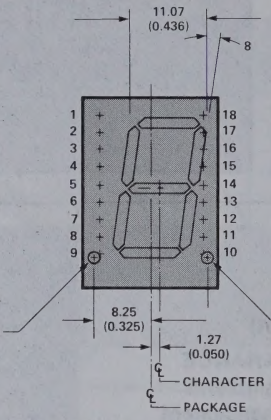
| Part No. HDSP | Description | Package Drawing |
|---|---|---|
| -3400 | Common Anode Left Hand Decimal | A |
| -3401 | Common Anode Right Hand Decimal | B |
| -3403 | Common Cathode Right Hand Decimal | C |
| -3405 | Common Cathode Left Hand Decimal | D |
| -3406 | Universal Overflow ±1 Right Hand Decimal | E |

Note: Universal pinout brings the anode and cathode of each segment's LED out to separate pins. See internal diagram E.

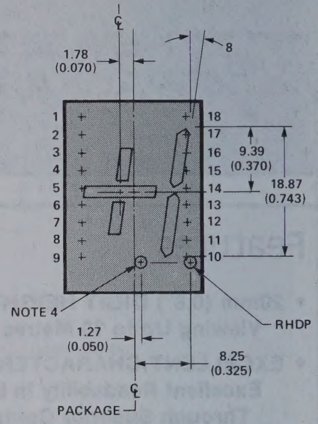
## Package Dimensions


11.07
(0.436)
8°
13.08
(0.515)
10.16
(0.400)
20.32
(0.800)
27.69 ± 0.25
(1.090 ± 0.010)
LHDP
8.25
(0.325)
1.27
(0.050)
NOTE 4
CHARACTER
PACKAGE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

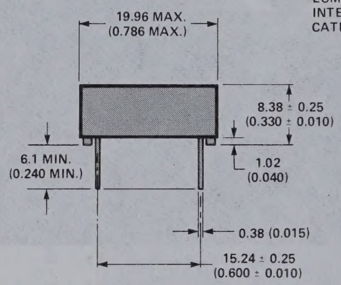
**FRONT VIEW A,D**


11.07
(0.436)
8°
8.25
(0.325)
1.27
(0.050)
RHDP
CHARACTER
PACKAGE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

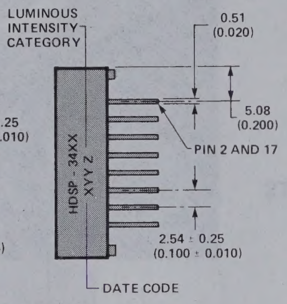
**FRONT VIEW B,C**


1.78
(0.070)
8°
9.39
(0.370)
18.87
(0.743)
NOTE 4
RHDP
1.27
(0.050)
8.25
(0.325)
PACKAGE
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

**FRONT VIEW E**


19.96 MAX.
(0.786 MAX.)
8.38 ± 0.25
(0.330 ± 0.010)
6.1 MIN.
(0.240 MIN.)
1.02
(0.040)
0.38 (0.015)
15.24 ± 0.25
(0.600 ± 0.010)

**END VIEW**

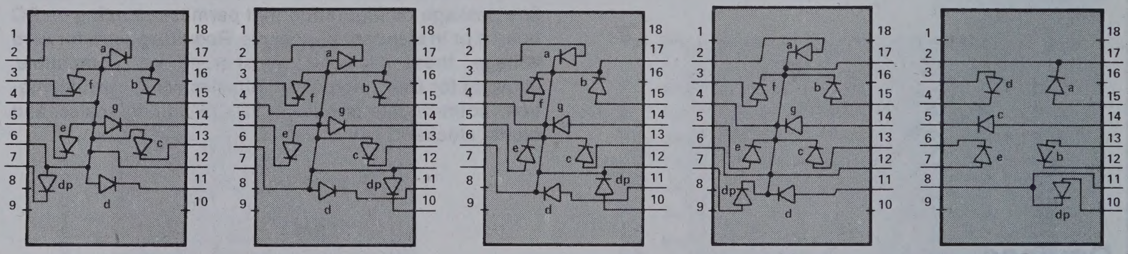

LUMINOUS
INTENSITY
CATEGORY
0.51
(0.020)
5.08
(0.200)
PIN 2 AND 17
HDSP - 34XX
XYY Z
2.54 ± 0.25
(0.100 ± 0.010)
DATE CODE

**SIDE VIEW**

| Pin | Function<br>A<br>-3400 | B<br>-3401 | C<br>-3403 | D<br>-3405 | E<br>-3406 |
|---|---|---|---|---|---|
| 1 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |
| 2 | CATHODE a | CATHODE a | ANODE a | ANODE a | CATHODE a |
| 3 | CATHODE f | CATHODE f | ANODE f | ANODE f | ANODE d |
| 4 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE d |
| 5 | CATHODE e | CATHODE e | ANODE e | ANODE e | CATHODE c |
| 6 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE e |
| 7 | CATHODE dp | NO. CONNEC. | NO. CONNEC. | ANODE dp | ANODE e |
| 8 | NO PIN | NO PIN | NO PIN | NO PIN | CATHODE dp |
| 9 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |
| 10 | NO PIN | CATHODE dp | ANODE dp | NO PIN | ANODE dp |
| 11 | CATHODE d | CATHODE d | ANODE d | ANODE d | CATHODE dp |
| 12 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE b |
| 13 | CATHODE c | CATHODE c | ANODE c | ANODE c | ANODE b |
| 14 | CATHODE g | CATHODE g | ANODE g | ANODE g | ANODE c |
| 15 | CATHODE b | CATHODE b | ANODE b | ANODE b | ANODE a |
| 16 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |
| 17 | ANODE[3] | ANODE[3] | CATHODE[6] | CATHODE[6] | CATHODE a |
| 18 | NO PIN | NO PIN | NO PIN | NO PIN | NO PIN |

NOTES:
1. Dimensions in millimetres and (inches).
2. All untoleranced dimensions are for reference only.
3. Redundant anodes.
4. Unused dp position.
5. See Internal Circuit Diagram.
6. Redundant cathodes.

## Internal Circuit Diagram


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
a
b
c
d
e
f
g
dp

A B C D E

## Absolute Maximum Ratings

| | |
|---|---|
| Average Power Dissipation per Segment or DP ($T_A = 50°C$)[1] | 100mW |
| Operating Temperature Range | -40° C to +85° C |
| Storage Temperature Range | -40° C to +85° C |
| Peak Forward Current per Segment or DP ($T_A = 50°C$, Pulse Width = 1.2ms)[2] | 200mA |
| DC Forward Current per Segment or DP ($T_A = 50°C$)[1] | 50mA |
| Reverse Voltage per Segment or DP | 6.0V |
| Lead Soldering Temperature (1.6mm [1/16 inch] Below Seating Plane) | 260° C for 3 sec. |

Notes:
1. Derate maximum DC current above $T_A = 50°C$ at 1mA/°C per segment, see Figure 2.
2. See Figure 1 to establish pulsed operating conditions.

# Electrical/Optical Characteristics at $T_A = 25°C$

| Description | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment (Digit Average)[1] | $I_v$ | $I_F = 20mA$ | 500 | 900 | | µcd |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 655 | | nm |
| Dominant Wavelength[2] | $\lambda_d$ | | | 640 | | nm |
| Forward Voltage, any Segment or DP | $V_F$ | $I_F = 20mA$ | | 1.6 | 2.0 | V |
| Reverse Current, any Segment or DP | $I_R$ | $V_R = 5V$ | | 10 | | µA |
| Rise and Fall Time[3] | $t_r$, $t_f$ | | | 10 | | ns |
| Temperature Coefficient of Forward Voltage | $\Delta V_F/°C$ | $I_F = 20mA$ | | -1.5 | | mV/°C |
| Thermal Resistance LED Junction-to-Pin | $R\theta_{J-PIN}$ | | | 375 | | °C/W/Seg |

**Notes:**

1. The digits are categorized for luminous intensity with the intensity category designated by a letter located on the right hand side of the package.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE Chromaticity Diagram and is that single wavelength which defines the color of the device.
3. Time for a 10% - 90% change of light intensity for step change in current.

### Electrical

The HDSP-3400 series of display devices are composed of eight light emitting diodes, with the light from each LED optically stretched to form individual segments and a decimal point. The LEDs have the P-N junction diffused into a GaAsP epitaxial layer on a GaAs substrate.

These display devices are designed for strobed operation at high peak currents. The typical forward voltage values, scaled from Figure 4, should be used for calculating the current limiting resistor values and typical power dissipation. Expected maximum $V_F$ values for the purpose of driver circuit design may be calculated using the following $V_F$ model:

$V_F = 1.78V + I_{PEAK}\ (3.7\Omega)$
For: $30mA \leq I_{PEAK} \leq 200mA$

### Contrast Enhancement

The objective of contrast enhancement is to provide good display readability in the end use ambient light. The concept is to have the OFF-segments blend into the display background and to have the ON-segments stand out vividly against this same background. To achieve this goal the HDSP-3400 displays use a gray package and untinted segments to maximize readability in bright ambients.

Contrast enhancement is achieved by using one of the following filter products: SGL Homalite H100-1605 RED or H100-1804 PURPLE: Panelgraphic RUBY RED 60, DARK RED 63 or PURPLE 90; Plexiglass 2423; 3M Light Control Film (louvered filters) in 80% Neutral Density, RED 655, VIOLET or PURPLE colors.

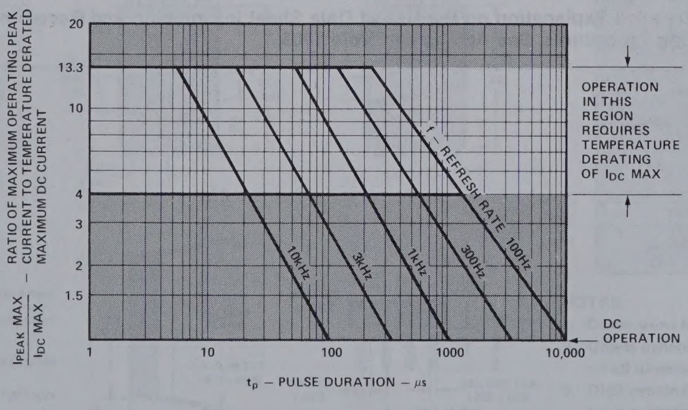


**Figure 1. Maximum Allowable Peak Current vs. Pulse Duration.**

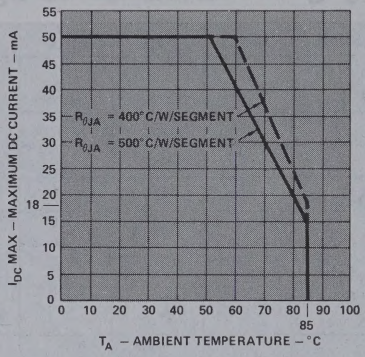


**Figure 2. Maximum Allowable DC Current per Segment vs. Ambient Temperature. Deratings Based on Maximum Allowed Thermal Resistance Values, LED Junction-to-Ambient on a per Segment Basis. $T_J$MAX=100°C.**

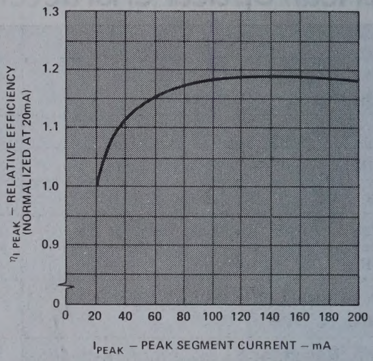


**Figure 3. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Segment Current.**

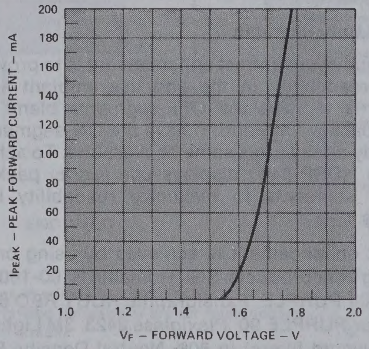


**Figure 4. Peak Forward Segment Current vs. Peak Forward Voltage.**

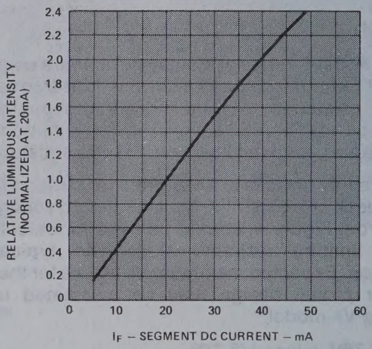


**Figure 5. Relative Luminous Intensity vs. DC Forward Current.**

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, See Application Note 1005.**

HEWLETT PACKARD

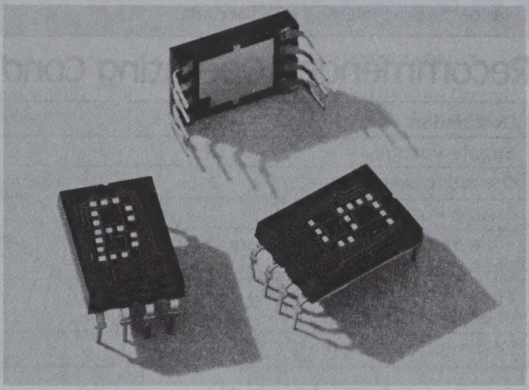
# NUMERIC and HEXADECIMAL INDICATORS

5082-7300
5082-7302
5082-7304
5082-7340

TECHNICAL DATA FEBRUARY 1982

## Features

- **NUMERIC 5082-7300/-7302**
  **0-9, Test State, Minus Sign, Blank States**
  **Decimal Point**
    **7300 Right Hand D.P.**
    **7302 Left Hand D.P.**
- **HEXADECIMAL 5082-7340**
  **0-9, A-F, Base 16 Operation**
  **Blanking Control, Conserves Power**
  **No Decimal Point**
- **DTL/TTL COMPATIBLE**
- **INCLUDES DECODER/DRIVER WITH 5 BIT MEMORY**
  **8421 Positive Logic Input**
- **4 x 7 DOT MATRIX ARRAY**
  **Shaped Character, Excellent Readibility**
- **STANDARD .600 INCH x .400 INCH DUAL-IN-LINE PACKAGE INCLUDING CONTRAST FILTER**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  **Assures Uniformity of Light Output from Unit to Unit within a Single Category**



## Description

The HP 5082-7300 series solid state numeric and hexadecimal indicators with on-board decoder/driver and memory provide a reliable, low-cost method for displaying digital information.

The 5082-7300 numeric indicator decodes positive 8421 BCD logic inputs into characters 0-9, a "-" sign, a test pattern, and four blanks in the invalid BCD states, The unit employs a right-hand decimal point. Typical applications include point-of-sale terminals, instrumentation, and computer systems.

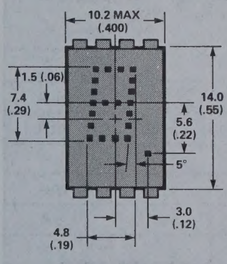
The 5082-7302 is the same as the 5082-7300, except that the decimal point is located on the left-hand side of the digit.

The 5082-7340 hexadecimal indicator decodes positive 8421 logic inputs into 16 states, 0-9 and A-F. In place of the decimal point an input is provided for blanking the display (all LED's off), without losing the contents of the memory. Applications include terminals and computer systems using the base-16 character set.

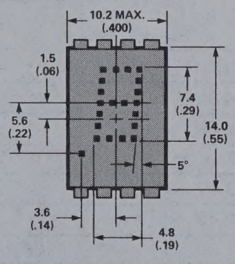
The 5082-7304 is a (± 1.) overrange character, including decimal point, used in instrumentation applications.

## Package Dimensions

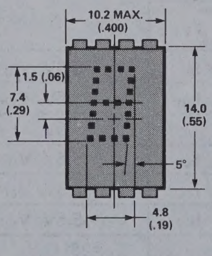
7300

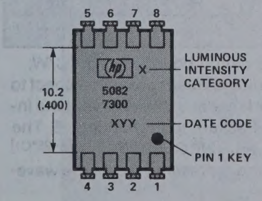

10.2 MAX
(.400)
1.5 (.06)
7.4
(.29)
14.0
(.55)
5.6
(.22)
5°
3.0
(.12)
4.8
(.19)

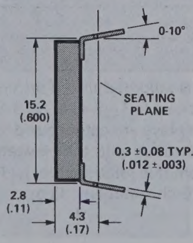
7302

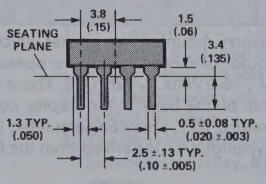

10.2 MAX.
(.400)
1.5
(.06)
5.6
(.22)
7.4
(.29)
14.0
(.55)
5°
3.6
(.14)
4.8
(.19)

7340


10.2 MAX.
(.400)
1.5 (.06)
7.4
(.29)
14.0
(.55)
5°
4.8
(.19)


5 6 7 8
10.2
(.400)
hp
5082
7300
XYY
X
LUMINOUS INTENSITY CATEGORY
DATE CODE
PIN 1 KEY
4 3 2 1


0-10°
15.2
(.600)
SEATING PLANE
0.3 ±0.08 TYP.
(.012 ±.003)
2.8
(.11)
4.3
(.17)


3.8
(.15)
1.5
(.06)
SEATING PLANE
3.4
(.135)
1.3 TYP.
(.050)
0.5 ±0.08 TYP.
(.020 ±.003)
2.5 ±.13 TYP.
(.10 ±.005)

| PIN | FUNCTION | |
|---|---|---|
| | 5082-7300 and 7302 Numeric | 5082-7340 Hexadecimal |
| 1 | Input 2 | Input 2 |
| 2 | Input 4 | Input 4 |
| 3 | Input 8 | Input 8 |
| 4 | Decimal point | Blanking control |
| 5 | Latch enable | Latch enable |
| 6 | Ground | Ground |
| 7 | $V_{CC}$ | $V_{CC}$ |
| 8 | Input 1 | Input 1 |

NOTES:
1. Dimensions in millimetres and (inches).
2. Unless otherwise specified, the tolerance on all dimensions is ±.38mm (±.015")
3. Digit center line is ±.25mm (±.01") from package center line.

## Absolute Maximum Ratings

| Description | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage temperature, ambient | $T_S$ | −40 | +100 | °C |
| Operating temperature, case (1,2) | $T_C$ | −20 | +85 | °C |
| Supply voltage (3) | $V_{CC}$ | −0.5 | +7.0 | V |
| Voltage applied to input logic, dp and enable pins | $V_I, V_{DP}, V_E$ | −0.5 | +7.0 | V |
| Voltage applied to blanking input (7) | $V_B$ | −0.5 | $V_{CC}$ | V |
| Maximum solder temperature at 1.59mm (.062 inch) below seating plane; $t \leqslant 5$ seconds | | | 230 | °C |

## Recommended Operating Conditions

| Description | Symbol | Min. | Nom. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| Operating temperature, case | $T_C$ | -20 | | +85 | °C |
| Enable Pulse Width | $t_W$ | 120 | | | nsec |
| Time data must be held before positive transition of enable line | $t_{SETUP}$ | 50 | | | nsec |
| Time data must be held after positive transition of enable line | $t_{HOLD}$ | 50 | | | nsec |
| Enable pulse rise time | $t_{TLH}$ | | | 200 | nsec |

## Electrical/Optical Characteristics ($T_C$ = -20°C to +85°C, unless otherwise specified).

| Description | Symbol | Test Conditions | Min. | Typ. (4) | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Current | $I_{CC}$ | $V_{CC}$=5.5V (Numeral 5 and dp lighted) | | 112 | 170 | mA |
| Power dissipation | $P_T$ | | | 560 | 935 | mW |
| Luminous intensity per LED (Digit average) (5,6) | $I_v$ | $V_{CC}$=5.0V, $T_C$=25°C | 32 | 70 | | μcd |
| Logic low-level input voltage | $V_{IL}$ | $V_{CC}$=4.5V | | | 0.8 | V |
| Logic high-level input voltage | $V_{IH}$ | | 2.0 | | | V |
| Enable low-voltage; data being entered | $V_{EL}$ | | | | 0.8 | V |
| Enable high-voltage; data not being entered | $V_{EH}$ | | 2.0 | | | V |
| Blanking low-voltage; display not blanked (7) | $V_{BL}$ | | | | 0.8 | V |
| Blanking high-voltage; display blanked (7) | $V_{BH}$ | | 3.5 | | | V |
| Blanking low-level input current (7) | $I_{BL}$ | $V_{CC}$=5.5V, $V_{BL}$=0.8V | | | 20 | μA |
| Blanking high-level input current (7) | $I_{BH}$ | $V_{CC}$=5.5V, $V_{BH}$=4.5V | | | 2.0 | mA |
| Logic low-level input current | $I_{IL}$ | $V_{CC}$=5.5V, $V_{IL}$=0.4V | | | −1.6 | mA |
| Logic high-level input current | $I_{IH}$ | $V_{CC}$=5.5V, $V_{IH}$=2.4V | | | +250 | μA |
| Enable low-level input current | $I_{EL}$ | $V_{CC}$=5.5V, $V_{EL}$=0.4V | | | −1.6 | mA |
| Enable high-level input current | $I_{EH}$ | $V_{CC}$=5.5V, $V_{EH}$=2.4V | | | +250 | μA |
| Peak wavelength | $\lambda_{PEAK}$ | $T_C$=25°C | | 655 | | nm |
| Dominant Wavelength (8) | $\lambda_d$ | $T_C$=25°C | | 640 | | nm |
| Weight | | | | 0.8 | | gm |

Notes: 1. Nominal thermal resistance of a display mounted in a socket which is soldered into a printed circuit board: $\Theta_{JA}$=50°C/W; $\Theta_{JC}$=15°C/W; 2. $\Theta_{CA}$ of a mounted display should not exceed 35°C/W for operation up to $T_C$ = +85°C. 3. Voltage values are with respect to device ground, pin 6. 4. All typical values at $V_{CC}$=5.0 Volts, $T_C$=25°C. 5. These displays are categorized for luminous intensity with the intensity category designated by a letter located on the back of the display contiguous with the Hewlett-Packard logo marking. 6. The luminous intensity at a specific case temperature, $I_v(T_C)$ may be calculated from this relationship: $I_v(T_C)=I_v\,(25°C)\,e^{[-.0188/°C\,(T_C-25°C)]}$ 7. Applies only to 7340. 8. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.

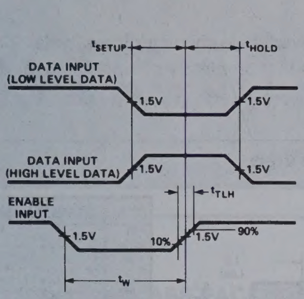

$t_{SETUP}$
$t_{HOLD}$
DATA INPUT (LOW LEVEL DATA)
1.5V
1.5V
DATA INPUT (HIGH LEVEL DATA)
1.5V
1.5V
ENABLE INPUT
$t_{TLH}$
1.5V
10%
1.5V
90%
$t_W$

**Figure 1. Timing Diagram of 5082-7300 Series Logic.**

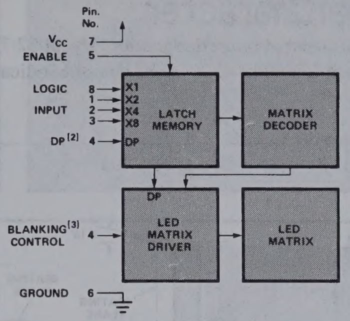

Pin. No.
$V_{CC}$ 7
ENABLE 5
LOGIC INPUT 8 1 2 3
X1 X2 X4 X8
DP[2] 4
DP
LATCH MEMORY
MATRIX DECODER
DP
BLANKING[3] CONTROL 4
LED MATRIX DRIVER
LED MATRIX
GROUND 6

**Figure 2. Block Diagram of 5082-7300 Series Logic.**

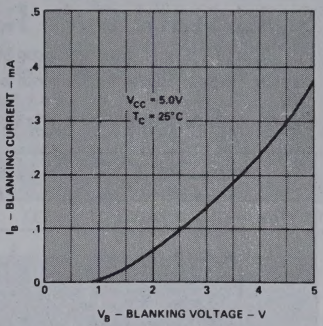


**Figure 3. Typical Blanking Control Current vs. Voltage for 5082-7340.**

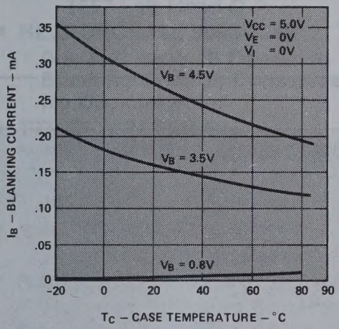


**Figure 4. Typical Blanking Control Input Current vs. Temperature 5082-7340.**

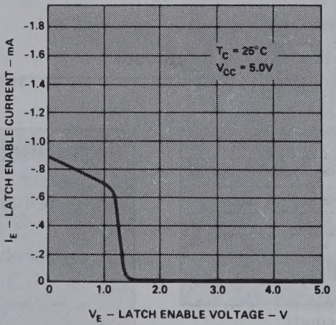


**Figure 5. Typical Latch Enable Input Current vs. Voltage for the 5082-7300 Series Devices.**

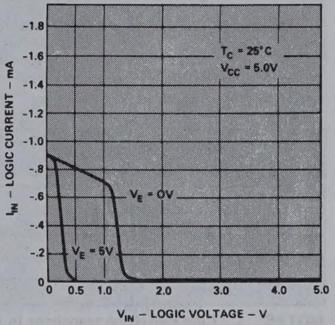


**Figure 6. Typical Logic and Decimal Point Input Current vs. Voltage for the 5082-7300 Series Devices. Decimal Point Applies to 5082-7300 and -7302 Only.**

| TRUTH TABLE | | | | | |
|---|---|---|---|---|---|
| BCD DATA[1] | | | | 5082-7300/7302 | 5082-7340 |
| $X_8$ | $X_4$ | $X_2$ | $X_1$ | | |
| L | L | L | L | 0 | 0 |
| L | L | L | H | 1 | 1 |
| L | L | H | L | 2 | 2 |
| L | L | H | H | 3 | 3 |
| L | H | L | L | 4 | 4 |
| L | H | L | H | 5 | 5 |
| L | H | H | L | 6 | 6 |
| L | H | H | H | 7 | 7 |
| H | L | L | L | 8 | 8 |
| H | L | L | H | 9 | 9 |
| H | L | H | L | ⊟ | A |
| H | L | H | H | (BLANK) | B |
| H | H | L | L | (BLANK) | C |
| H | H | L | H | - | D |
| H | H | H | L | (BLANK) | E |
| H | H | H | H | (BLANK) | F |
| DECIMAL PT.[2] | | | ON | | $V_{DP}$ = L |
| | | | OFF | | $V_{DP}$ = H |
| ENABLE[1] | | | LOAD DATA | | $V_E$ = L |
| | | | LATCH DATA | | $V_E$ = H |
| BLANKING[3] | | | DISPLAY-ON | | $V_B$ = L |
| | | | DISPLAY-OFF | | $V_B$ = H |

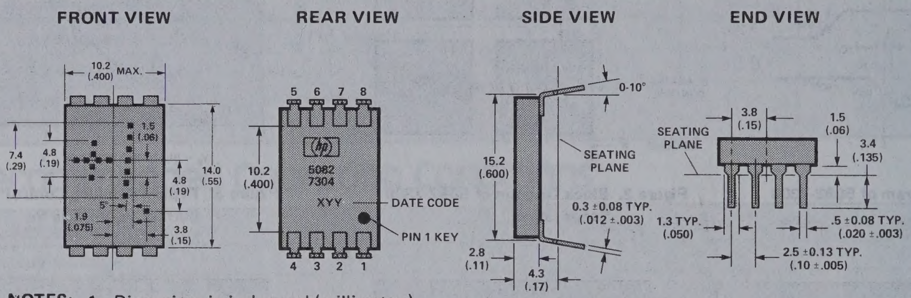
Notes:

1. H = Logic High; L = Logic Low. With the enable input at logic high changes in BCD input logic levels or D.P. input have no effect upon display memory, displayed character, or D.P.
2. The decimal point input, DP, pertains only to the 5082-7300 and 5082-7302 displays.
3. The blanking control input, B, pertains only to the 5082-7340 hexadecimal display. Blanking input has no effect upon display memory.

# Solid State Over Range Character

For display applications requiring a ±, 1, or decimal point designation, the 5082-7304 over range character is available. This display module comes in the same package as the 5082-7300 series numeric indicator and is completely compatible with it.

# Package Dimensions


FRONT VIEW
REAR VIEW
SIDE VIEW
END VIEW
10.2 (.400) MAX.
7.4 (.29)
4.8 (.19)
1.5 (.06)
4.8 (.19)
14.0 (.55)
5°
1.9 (.075)
3.8 (.15)
5 6 7 8
10.2 (.400)
5082 7304
XYY
DATE CODE
PIN 1 KEY
4 3 2 1
0-10°
SEATING PLANE
15.2 (.600)
0.3 ±0.08 TYP. (.012 ±.003)
2.8 (.11)
4.3 (.17)
3.8 (.15)
1.5 (.06)
SEATING PLANE
3.4 (.135)
1.3 TYP. (.050)
.5 ±0.08 TYP. (.020 ±.003)
2.5 ±0.13 TYP. (.10 ±.005)

| PIN | FUNCTION |
|---|---|
| 1 | Plus |
| 2 | Numeral One |
| 3 | Numeral One |
| 4 | DP |
| 5 | Open |
| 6 | Open |
| 7 | $V_{cc}$ |
| 8 | Minus/Plus |

**NOTES:** 1. Dimensions in inches and (millimeters).
2. Unless otherwise specified, the tolerance on all dimensions is ±.015 inches. (± .38 mm)

**5082—7304**

### TRUTH TABLE FOR 5082-7304

| CHARACTER | PIN | | | |
|---|---|---|---|---|
| | 1 | 2,3 | 4 | 8 |
| + | H | X | X | H |
| — | L | X | X | H |
| 1 | X | H | X | X |
| Decimal Point | X | X | H | X |
| Blank | L | L | L | L |

**NOTES:** L: Line switching transistor in Fig. 7 cutoff.
H: Line switching transistor in Fig. 7 saturated.
X: 'don't care'

**TYPICAL DRIVING CIRCUIT FOR 5082-7304.**

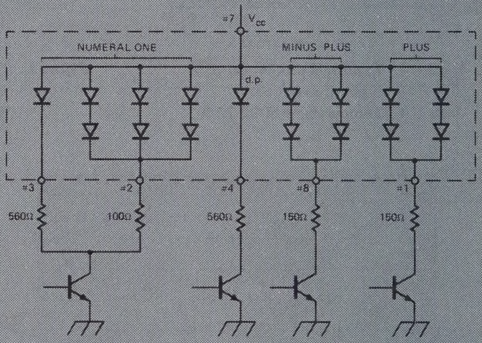

#7
$V_{cc}$
NUMERAL ONE
MINUS PLUS
PLUS
d.p.
#3
#2
#4
#8
#1
560Ω
100Ω
560Ω
150Ω
150Ω

Figure 7.

# Absolute Maximum Ratings

| DESCRIPTION | SYMBOL | MIN | MAX | UNIT |
|---|---|---|---|---|
| Storage temperature, ambient | $T_s$ | -40 | +100 | °C |
| Operating temperature, case | $T_C$ | -20 | +85 | °C |
| Forward current, each LED | $I_F$ | | 10 | mA |
| Reverse voltage, each LED | $V_R$ | | 4 | V |

## RECOMMENDED OPERATING CONDITIONS

| | SYMBOL | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| LED supply voltage | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| Forward current, each LED | $I_F$ | | 5.0 | 10 | mA |

**NOTE:**
LED current must be externally limited. Refer to figure 7 for recommended resistor values.

# Electrical/Optical Characteristics (T$_C$ = -20°C TO +85°C, UNLESS OTHERWISE SPECIFIED)

| DESCRIPTION | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Forward Voltage per LED | $V_F$ | $I_F$ = 10 mA | | 1.6 | 2.0 | V |
| Power dissipation | $P_T$ | $I_F$ = 10 mA<br>all diodes lit | | 250 | 320 | mW |
| Luminous Intensity per LED (digit average) | $I_\nu$ | $I_F$ = 6 mA<br>$T_C$ = 25°C | 32 | 70 | | µcd |
| Peak wavelength | $\lambda$peak | $T_C$ = 25°C | | 655 | | nm |
| Dominant Wavelength | $\lambda$d | $T_C$ = 25°C | | 640 | | nm |
| Weight | | | | 0.8 | | gm |

HEWLETT PACKARD

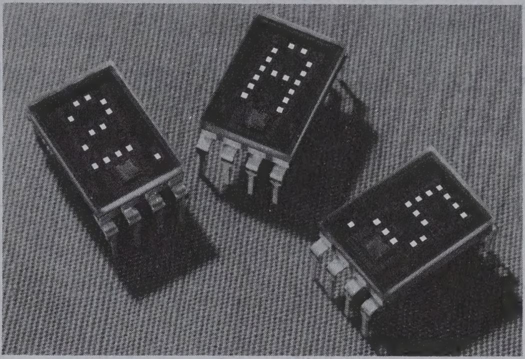
# NUMERIC AND HEXADECIMAL DISPLAYS FOR INDUSTRIAL APPLICATIONS

5082-7356
5082-7357
5082-7358
5082-7359

TECHNICAL DATA FEBRUARY 1982

## Features

- **CERAMIC/GLASS PACKAGE**
- **ADDED RELIABILITY**
- **NUMERIC 5082-7356/-7357**
  - **0-9, Test State, Minus Sign, Blank States**
  - **Decimal Point**
    - **7356 Right Hand D.P.**
    - **7357 Left Hand D.P.**
- **HEXADECIMAL 5082-7359**
  - **0-9, A-F, Base 16 Operation**
  - **Blanking Control, Conserves Power**
  - **No Decimal Point**
- **TTL COMPATIBLE**
- **INCLUDES DECODER/DRIVER WITH 5 BIT MEMORY**
  - **8421 Positive Logic Input and Decimal Point**
- **4 x 7 DOT MATRIX ARRAY**
  - **Shaped Character, Excellent Readability**
- **STANDARD DUAL-IN-LINE PACKAGE**
  - **15.2mm x 10.2mm (.6 inch x .4 inch)**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  - **Assures Uniformity of Light Output from Unit to Unit within a Single Category**



## Description

The HP 5082-7350 series solid state numeric and hexadecimal indicators with on-board decoder/driver and memory provide 7.4mm (0.29 inch) displays for use in adverse industrial environments.

The 5082-7356 numeric indicator decodes positive 8421 BCD logic inputs into characters 0-9, a "–" sign, a test pattern, and four blanks in the invalid BCD states. The unit employs a right-hand decimal point. Typical applications include control systems, instrumentation, communication systems and transportation equipment.

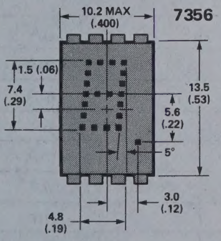
The 5082-7357 is the same as the 5082-7356 except that the decimal point is located on the left-hand side of the digit.

The 5082-7359 hexadecimal indicator decodes positive 8421 logic inputs into 16 states, 0-9 and A-F. In place of the decimal point an input is provided for blanking the display (all LED's off), without losing the contents of the memory. Applications include terminals and computer systems using the base-16 character set.

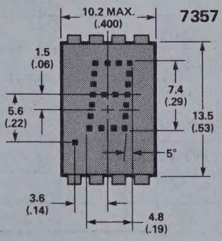
The 5082-7358 is a "±1." overrange display, including a right hand decimal point.

## Package Dimensions

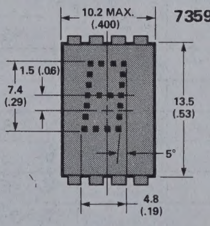
7356


10.2 MAX
(.400)
1.5 (.06)
7.4
(.29)
13.5
(.53)
5.6
(.22)
5°
3.0
(.12)
4.8
(.19)

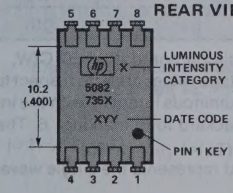
7357


10.2 MAX.
(.400)
1.5
(.06)
5.6
(.22)
7.4
(.29)
13.5
(.53)
5°
3.6
(.14)
4.8
(.19)

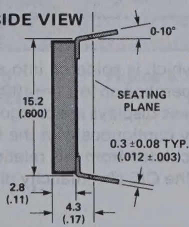
7359


10.2 MAX.
(.400)
1.5 (.06)
7.4
(.29)
13.5
(.53)
5°
4.8
(.19)

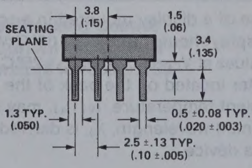
REAR VIEW


5 6 7 8
LUMINOUS INTENSITY CATEGORY
10.2
(.400)
X
5082
735X
XYY
DATE CODE
PIN 1 KEY
4 3 2 1

SIDE VIEW


0-10°
SEATING PLANE
15.2
(.600)
0.3 ±0.08 TYP.
(.012 ±.003)
2.8
(.11)
4.3
(.17)

END VIEW


3.8
(.15)
1.5
(.06)
SEATING PLANE
3.4
(.135)
1.3 TYP.
(.050)
0.5 ±0.08 TYP.
(.020 ±.003)
2.5 ±.13 TYP.
(.10 ±.005)

| PIN | FUNCTION<br>5082-7356 AND 7357 NUMERIC | <br>5082-7359 HEXA-DECIMAL |
|---|---|---|
| 1 | Input 2 | Input 2 |
| 2 | Input 4 | Input 4 |
| 3 | Input 8 | Input 8 |
| 4 | Decimal point | Blanking control |
| 5 | Latch enable | Latch enable |
| 6 | Ground | Ground |
| 7 | $V_{CC}$ | $V_{CC}$ |
| 8 | Input 1 | Input 1 |

NOTES:
1. Dimensions in millimetres and (inches).
2. Unless otherwise specified, the tolerance on all dimensions is ±.38mm (±.015")
3. Digit center line is ±.25mm (±.01") from package center line.

## Absolute Maximum Ratings

| Description | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage temperature, ambient | $T_S$ | −65 | +125 | °C |
| Operating temperature, ambient [1,2] | $T_A$ | −55 | +100 | °C |
| Supply voltage [3] | $V_{CC}$ | −0.5 | +7.0 | V |
| Voltage applied to input logic, dp and enable pins | $V_I, V_{DP}, V_E$ | −0.5 | +7.0 | V |
| Voltage applied to blanking input [7] | $V_B$ | −0.5 | $V_{CC}$ | V |
| Maximum solder temperature at 1.59mm (.062 inch) below seating plane; t ⩽ 5 seconds | | | 260 | °C |

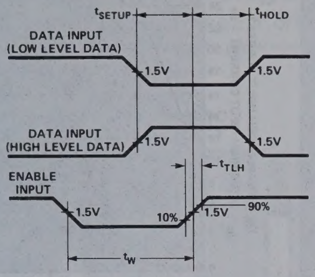
## Recommended Operating Conditions

| Description | Symbol | Min. | Nom. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| Operating temperature, ambient | $T_A$ | -20 | | +70 | °C |
| Enable Pulse Width | $t_W$ | 100 | | | nsec |
| Time data must be held before positive transition of enable line | $t_{SETUP}$ | 50 | | | nsec |
| Time data must be held after positive transition of enable line | $t_{HOLD}$ | 50 | | | nsec |
| Enable pulse rise time | $t_{TLH}$ | | | 200 | nsec |

## Electrical/Optical Characteristics (TA = -20° C to +70° C, Unless Otherwise Specified)

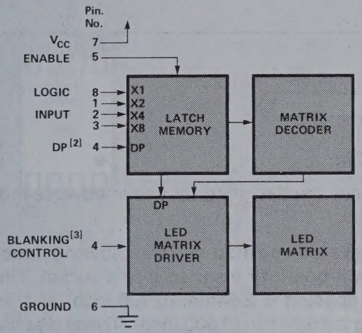
| Description | Symbol | Test Conditions | Min. | Typ.[4] | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Current | $I_{CC}$ | $V_{CC}$=5.5V (Numeral 5 and dp lighted) | | 112 | 170 | mA |
| Power dissipation | $P_T$ | | | 560 | 935 | mW |
| Luminous intensity per LED (Digit average) [5,6] | $I_v$ | $V_{CC}$=5.0V, $T_A$=25°C | 40 | 85 | | μcd |
| Logic low-level input voltage | $V_{IL}$ | $V_{CC}$=4.5V | | | 0.8 | V |
| Logic high-level input voltage | $V_{IH}$ | | 2.0 | | | V |
| Enable low-voltage; data being entered | $V_{EL}$ | | | | 0.8 | V |
| Enable high-voltage; data not being entered | $V_{EH}$ | | 2.0 | | | V |
| Blanking low-voltage; display not blanked [7] | $V_{BL}$ | | | | 0.8 | V |
| Blanking high-voltage; display blanked [7] | $V_{BH}$ | | 3.5 | | | V |
| Blanking low-level input current [7] | $I_{BL}$ | $V_{CC}$=5.5V, $V_{BL}$=0.8V | | | 50 | μA |
| Blanking high-level input current [7] | $I_{BH}$ | $V_{CC}$=5.5V, $V_{BH}$=4.5V | | | 1.0 | mA |
| Logic low-level input current | $I_{IL}$ | $V_{CC}$=5.5V, $V_{IL}$=0.4V | | | −1.6 | mA |
| Logic high-level input current | $I_{IH}$ | $V_{CC}$=5.5V, $V_{IH}$=2.4V | | | +100 | μA |
| Enable low-level input current | $I_{EL}$ | $V_{CC}$=5.5V, $V_{EL}$=0.4V | | | −1.6 | mA |
| Enable high-level input current | $I_{EH}$ | $V_{CC}$=5.5V, $V_{EH}$=2.4V | | | +130 | μA |
| Peak wavelength | $\lambda_{PEAK}$ | $T_A$=25°C | | 655 | | nm |
| Dominant Wavelength [8] | $\lambda_d$ | $T_A$=25°C | | 640 | | nm |
| Weight | | | | 1.0 | | gm |

Notes: 1. Nominal thermal resistance of a display mounted in a socket which is soldered into a printed circuit board: $\Theta_{JA}$=50° C/W; $\Theta_{JC}$=15° C/W; 2. $\Theta_{CA}$ of a mounted display should not exceed 35° C/W for operation up to $T_A$=+100° C. 3. Voltage values are with respect to device ground, pin 6. 4. All typical values at $V_{CC}$=5.0 Volts, $T_A$=25° C. 5. These displays are categorized for luminous intensity with the intensity category designated by a letter located on the back of the display contiguous with the Hewlett-Packard logo marking. 6. The luminous intensity at a specific ambient temperature, $I_V(T_A)$, may be calculated from this relationship: $I_V(T_A) = I_{V(25^\circ C)}\,(.985)^{[T_A - 25^\circ C]}$ 7. Applies only to 7359. 8. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.



$t_{SETUP}$
$t_{HOLD}$
DATA INPUT (LOW LEVEL DATA)
1.5V
1.5V
DATA INPUT (HIGH LEVEL DATA)
1.5V
1.5V
$t_{TLH}$
ENABLE INPUT
1.5V
10%
1.5V
90%
$t_W$

**Figure 1. Timing Diagram of 5082-7350 Series Logic.**



Pin. No.
$V_{CC}$ 7
ENABLE 5
LOGIC INPUT
8 X1
1 X2
2 X4
3 X8
DP[2] 4 DP
LATCH MEMORY
MATRIX DECODER
DP
BLANKING[3] CONTROL 4
LED MATRIX DRIVER
LED MATRIX
GROUND 6

**Figure 2. Block Diagram of 5082-7350 Series Logic.**

| TRUTH TABLE | | | | | |
|---|---|---|---|---|---|
| BCD DATA[1] | | | | 5082-7356/7357 | 5082-7359 |
| $X_8$ | $X_4$ | $X_2$ | $X_1$ | | |
| L | L | L | L | 0 | 0 |
| L | L | L | H | 1 | 1 |
| L | L | H | L | 2 | 2 |
| L | L | H | H | 3 | 3 |
| L | H | L | L | 4 | 4 |
| L | H | L | H | 5 | 5 |
| L | H | H | L | 6 | 6 |
| L | H | H | H | 7 | 7 |
| H | L | L | L | 8 | 8 |
| H | L | L | H | 9 | 9 |
| H | L | H | L | B | A |
| H | L | H | H | (BLANK) | B |
| H | H | L | L | (BLANK) | C |
| H | H | L | H | - | D |
| H | H | H | L | (BLANK) | E |
| H | H | H | H | (BLANK) | F |
| DECIMAL PT.[2] | | | | ON | $V_{DP}$ = L |
| | | | | OFF | $V_{DP}$ = H |
| ENABLE[1] | | | | LOAD DATA | $V_E$ = L |
| | | | | LATCH DATA | $V_E$ = H |
| BLANKING[3] | | | | DISPLAY-ON | $V_B$ = L |
| | | | | DISPLAY-OFF | $V_B$ = H |

Notes:

1. H = Logic High; L = Logic Low. With the enable input at logic high changes in BCD input logic levels or D.P. input have no effect upon display memory, displayed character, or D.P.
2. The decimal point input, DP, pertains only to the 5082-7356 and 5082-7357 displays.
3. The blanking control input, B, pertains only to the 5082-7359 hexadecimal display. Blanking input has no effect upon display memory.

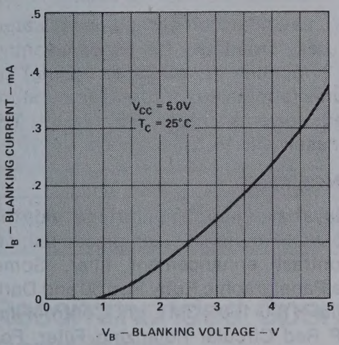


**Figure 3. Typical Blanking Control Current vs. Voltage for 5082-7359.**

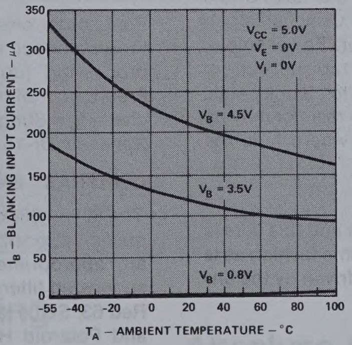


**Figure 4. Typical Blanking Control Input Current vs. Ambient Temperature for 5082-7359.**

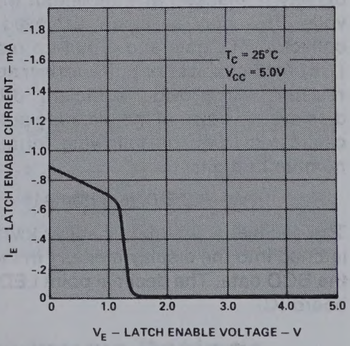


**Figure 5. Typical Latch Enable Input Current vs. Voltage.**

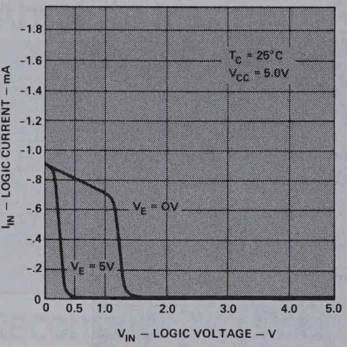


**Figure 6. Typical Logic and Decimal Point Input Current vs. Voltage.**

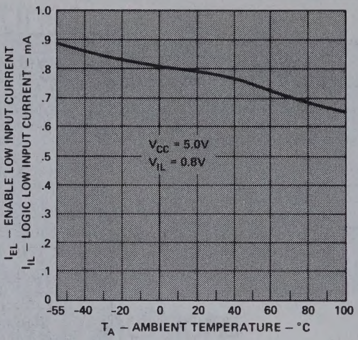


**Figure 7. Typical Logic and Enable Low Input Current vs. Ambient Temperature.**

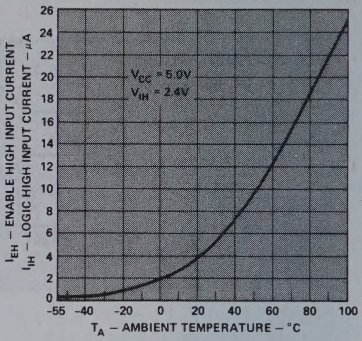


**Figure 8. Typical Logic and Enable High Input Current vs. Ambient Temperature.**

# Operational Considerations

## ELECTRICAL

The 5082-7350 series devices use a modified 4 x 7 dot matrix of light emitting diodes (LED's) to display decimal/hexadecimal numeric information. The LED's are driven by constant current drivers. BCD information is accepted by the display memory when the enable line is at logic low and the data is latched when the enable is at logic high. To avoid the latching of erroneous information, the enable pulse rise time should not exceed 200 nanoseconds. Using the enable pulse width and data setup and hold times listed in the Recommended Operating Conditions allows data to be clocked into an array of displays at a 6.7MHz rate.

The blanking control input on the 5082-7395 display blanks (turns off) the displayed hexadecimal information without disturbing the contents of display memory. The display is blanked at a minimum threshold level of 3.5 volts. This may be easily achieved by using an open collector TTL gate and a pull-up resistor. For example, (1/6) 7416 hexinverter buffer/driver and a 120 ohm pull-up resistor will provide sufficient drive to blank eight displays. The size of the blanking pull-up resistor may be calculated from the following formula, where N is the number of digits:

$$R_{blank} = (V_{CC} - 3.5V)/[N\ (1.0mA)]$$

The decimal point input is active low true and this data is latched into the display memory in the same fashion as is the BCD data. The decimal point LED is driven by the on-board IC.

## MECHANICAL

These displays are designed for use in adverse industrial environments.

These displays may be mounted by soldering directly to a printed circuit board or inserted into a socket. The lead-to-lead pin spacing is 2.54mm (0.100 inch) and the lead row spacing is 15.24mm (0.600 inch). These displays may be end stacked with 2.54mm (0.100 inch) spacing between outside pins of adjacent displays. Sockets such as Augat 324-AG2D (3 digits) or Augat 508-AG8D (one digit, right angle mounting) may be used.

The primary thermal path for power dissipation is through the device leads. Therefore, to insure reliable operation up to an ambient temperature of +100°C, it is important to maintain a case-to-ambient thermal resistance of less than 35°C/watt as measured on top of display pin 3.

Post solder cleaning may be accomplished using water, Freon/alcohol mixtures formulated for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents: Freon TF, Freon TE, Genesolv DI-15, Genesolv DE-15.

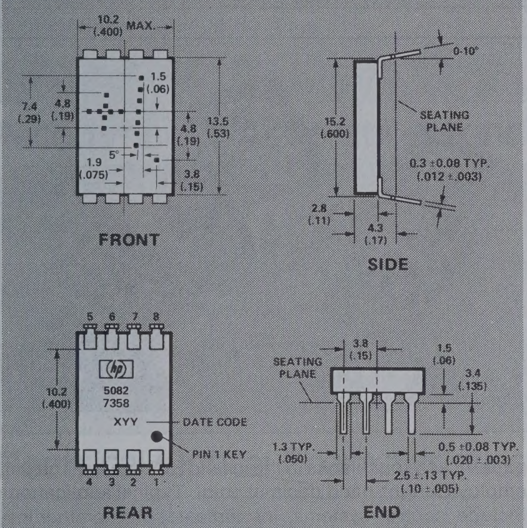
## CONTRAST ENHANCEMENT

The 5082-7350 displays have been designed to provide the maximum posible ON/OFF contrast when placed behind an appropriate contrast enhancement filter. Some suggested filters are Panelgraphic Ruby Red 60 and Dark Red 63, SGL Homalite H100-1605, 3M Light Control Film and Polaroid HRCP Red Circular Polarizing Filter. For further information see Hewlett-Packard Application Note 964.

# Solid State Over Range Character

For display applications requiring a ±, 1, or decimal point designation, the 5082-7358 over range character is available. This display module comes in the same package as the 5082-7350 series numeric indicator and is completely compatible with it.

## Package Dimensions


10.2 (.400) MAX.
1.5 (.06)
7.4 (.29)
4.8 (.19)
4.8 (.19)
13.5 (.53)
5°
1.9 (.075)
3.8 (.15)
FRONT
0-10°
15.2 (.600)
SEATING PLANE
0.3 ±0.08 TYP. (.012 ±.003)
2.8 (.11)
4.3 (.17)
SIDE
5 6 7 8
10.2 (.400)
5082
7358
XYY
DATE CODE
PIN 1 KEY
4 3 2 1
REAR
SEATING PLANE
3.8 (.15)
1.5 (.06)
3.4 (.135)
1.3 TYP. (.050)
0.5 ±0.08 TYP. (.020 ±.003)
2.5 ±.13 TYP. (.10 ±.005)
END

NOTES:
1. DIMENSIONS IN MILLIMETRES AND (INCHES).
2. UNLESS OTHERWISE SPECIFIED, THE TOLERANCE ON ALL DIMENSIONS IS ±.38 MM (± .015 INCHES).

| PIN | FUNCTION |
|---|---|
| 1 | Plus |
| 2 | Numeral One |
| 3 | Numeral One |
| 4 | DP |
| 5 | Open |
| 6 | Open |
| 7 | $V_{cc}$ |
| 8 | Minus/Plus |

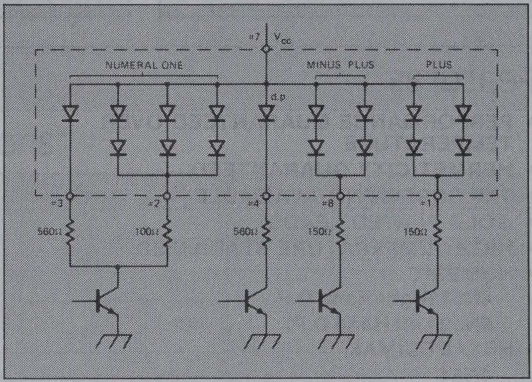

#7
$V_{cc}$
NUMERAL ONE
MINUS PLUS
PLUS
d.p
#3
#2
#4
#8
#1
560Ω
100Ω
560Ω
150Ω
150Ω

Figure 9. Typical Driving Circuit.

**TRUTH TABLE**

| CHARACTER | PIN | | | |
|---|---|---|---|---|
| | 1 | 2,3 | 4 | 8 |
| + | H | X | X | H |
| – | L | X | X | H |
| 1 | X | H | X | X |
| Decimal Point | X | X | H | X |
| Blank | L | L | L | L |

NOTES: L: Line switching transistor in Figure 9 cutoff.
H: Line switching transistor in Figure 9 saturated.
X: 'Don't care'

## Electrical/Optical Characteristics

**5082-7358** ($T_A$ = -20°C to 70°C, Unless Otherwise Specified)

| DESCRIPTION | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Forward Voltage per LED | $V_F$ | $I_F$ = 10 mA | | 1.6 | 2.0 | V |
| Power dissipation | $P_T$ | $I_F$ = 10 mA<br>all diodes lit | | 280 | 320 | mW |
| Luminous Intensity per LED (digit average) | $I_\nu$ | $I_F$ = 6 mA<br>$T_C$ = 25°C | 40 | 85 | | μcd |
| Peak wavelength | $\lambda_{peak}$ | $T_C$ = 25°C | | 655 | | nm |
| Dominant Wavelength | λd | $T_C$ = 25°C | | 640 | | nm |
| Weight | | | | 1.0 | | gm |

## Recommended Operating Conditions

| | SYMBOL | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| LED supply voltage | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| Forward current, each LED | $I_F$ | | 5.0 | 10 | mA |

NOTE:
LED current must be externally limited. Refer to Figure 9 for recommended resistor values.

## Absolute Maximum Ratings

| DESCRIPTION | SYMBOL | MIN. | MAX. | UNIT |
|---|---|---|---|---|
| Storage temperature, ambient | $T_S$ | -65 | +125 | °C |
| Operating temperature, ambient | $T_A$ | -55 | +100 | °C |
| Forward current, each LED | $I_F$ | | 10 | mA |
| Reverse voltage, each LED | $V_R$ | | 4 | V |

**HEWLETT PACKARD**

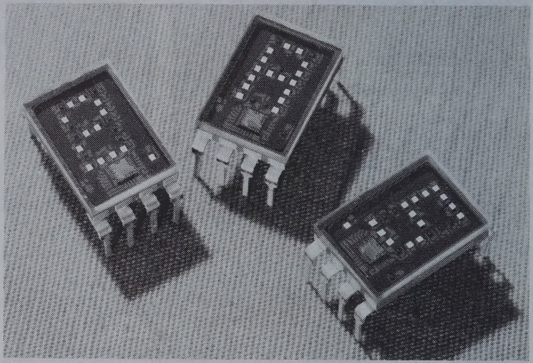
# HERMETIC NUMERIC AND HEXADECIMAL DISPLAYS FOR HIGH RELIABILITY APPLICATIONS

### 4N51 4N52 (5082-7391/92)
### 4N53 4N54 (5082-7393/95)
### ALSO TXV AND TXVB PARTS

TECHNICAL DATA FEBRUARY 1982

## Features

- **PERFORMANCE GUARANTEED OVER TEMPERATURE**
- **HERMETICITY GUARANTEED**
- **TXV SCREENING AVAILABLE**
- **GOLD PLATED LEADS**
- **HIGH TEMPERATURE STABILIZED**
- **NUMERIC**
  **4N51 Right Hand D.P.**
  **4N52 Left Hand D.P.**
- **HEXADECIMAL**
  **4N54**
- **TTL COMPATIBLE**
- **DECODER/DRIVER WITH 5 BIT MEMORY**
- **4 x 7 DOT MATRIX ARRAY**
  **Shaped Character, Excellent Readability**
- **STANDARD DUAL-IN-LINE PACKAGE**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  **Assures Uniformity of Light Output from Unit to Unit within a Single Category**



## Description

The 4N51-4N54 series solid state numeric and hexadecimal indicators with on-board decoder/driver and memory are hermetically tested 7.4mm (0.29 inch) displays for use in military and aerospace applications.

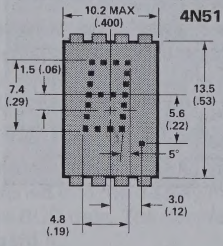
The 4N51 numeric indicator decodes positive 8421 BCD logic inputs into characters 0-9, a "—" sign, a test pattern, and four blanks in the invalid BCD states. The unit employs a right-hand decimal point. Typical applications include control systems, instrumentation, communication systems and transportation equipment.

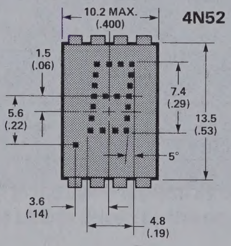
The 4N52 is the same as the 4N51 except that the decimal point is located on the left-hand side of the digit.

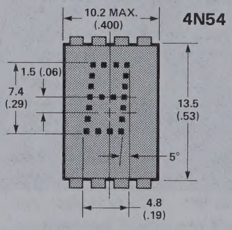
The 4N54 hexadecimal indicator decodes positive 8421 logic inputs into 16 states, 0-9 and A-F. In place of the decimal point an input is provided for blanking the display (all LED's off), without losing the contents of the memory. Applications include terminals and computer systems using the base-16 character set.

The 4N53 is a "±1." overrange display, including a right-hand decimal point.

## Package Dimensions*

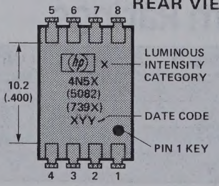

4N51
10.2 MAX
(.400)
1.5 (.06)
7.4
(.29)
5.6
(.22)
13.5
(.53)
5°
3.0
(.12)
4.8
(.19)


4N52
10.2 MAX.
(.400)
1.5
(.06)
5.6
(.22)
7.4
(.29)
13.5
(.53)
5°
3.6
(.14)
4.8
(.19)

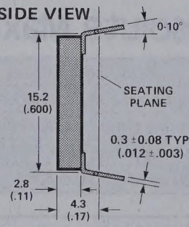

4N54
10.2 MAX.
(.400)
1.5 (.06)
7.4
(.29)
13.5
(.53)
5°
4.8
(.19)

| PIN | FUNCTION | |
|---|---|---|
| | 4N51<br>4N52<br>NUMERIC | 4N54<br>HEXA-DECIMAL |
| 1 | Input 2 | Input 2 |
| 2 | Input 4 | Input 4 |
| 3 | Input 8 | Input 8 |
| 4 | Decimal point | Blanking control |
| 5 | Latch enable | Latch enable |
| 6 | Ground | Ground |
| 7 | $V_{CC}$ | $V_{CC}$ |
| 8 | Input 1 | Input 1 |

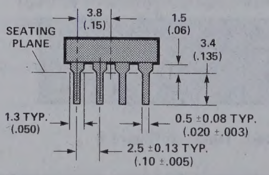
REAR VIEW


5
6
7
8
LUMINOUS INTENSITY CATEGORY
X
4N5X
(5082)
(739X)
XYY
DATE CODE
10.2
(.400)
PIN 1 KEY
4
3
2
1

SIDE VIEW


0-10°
15.2
(.600)
SEATING PLANE
0.3 ±0.08 TYP.
(.012 ±.003)
2.8
(.11)
4.3
(.17)

END VIEW


3.8
(.15)
1.5
(.06)
SEATING PLANE
3.4
(.135)
1.3 TYP.
(.050)
0.5 ±0.08 TYP.
(.020 ±.003)
2.5 ±0.13 TYP.
(.10 ±.005)

NOTES:
1. Dimensions in millimetres and (inches).
2. Unless otherwise specified, the tolerance on all dimensions is ±.38mm (±.015")
3. Digit center line is ±.25mm (±.01") from package center line.
4. Lead material is gold plated copper alloy.

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*JEDEC Registered Data.

# Absolute Maximum Ratings*

| Description | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage temperature, ambient | $T_S$ | −65 | +125 | °C |
| Operating temperature, ambient (1,2) | $T_A$ | −55 | +100 | °C |
| Supply voltage (3) | $V_{CC}$ | −0.5 | +7.0 | V |
| Voltage applied to input logic, dp and enable pins | $V_I, V_{DP}, V_E$ | −0.5 | +7.0 | V |
| Voltage applied to blanking input (7) | $V_B$ | −0.5 | $V_{CC}$ | V |
| Maximum solder temperature at 1.59mm (.062 inch) below seating plane; t ≤ 5 seconds | | | 260 | °C |

# Recommended Operating Conditions*

| Description | Symbol | Min. | Nom. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| Operating temperature, ambient (1,2) | $T_A$ | −55 | | +100 | °C |
| Enable Pulse Width | $t_W$ | 100 | | | nsec |
| Time data must be held before positive transition of enable line | $t_{SETUP}$ | 50 | | | nsec |
| Time data must be held after positive transition of enable line | $t_{HOLD}$ | 50 | | | nsec |
| Enable pulse rise time | $t_{TLH}$ | | | 200 | nsec |

# Electrical/Optical Characteristics* ($T_A$ = −55° C to +100° C, unless otherwise specified)

| Description | Symbol | Test Conditions | Min. | Typ. (4) | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Current | $I_{CC}$ | $V_{CC}$=5.5V (Numeral 5 and dp lighted) | | 112 | 170 | mA |
| Power dissipation | $P_T$ | | | 560 | 935 | mW |
| Luminous intensity per LED (Digit average) (5,6) | $I_v$ | $V_{CC}$=5.0V, $T_A$=25°C | 40 | 85 | | μcd |
| Logic low-level input voltage | $V_{IL}$ | $V_{CC}$=4.5V | | | 0.8 | V |
| Logic high-level input voltage | $V_{IH}$ | | 2.0 | | | V |
| Enable low-voltage; data being entered | $V_{EL}$ | | | | 0.8 | V |
| Enable high-voltage; data not being entered | $V_{EH}$ | | 2.0 | | | V |
| Blanking low-voltage; display not blanked (7) | $V_{BL}$ | | | | 0.8 | V |
| Blanking high-voltage; display blanked (7) | $V_{BH}$ | | 3.5 | | | V |
| Blanking low-level input current (7) | $I_{BL}$ | $V_{CC}$=5.5V, $V_{BL}$=0.8V | | | 50 | μA |
| Blanking high-level input current (7) | $I_{BH}$ | $V_{CC}$=5.5V, $V_{BH}$=4.5V | | | 1.0 | mA |
| Logic low-level input current | $I_{IL}$ | $V_{CC}$=5.5V, $V_{IL}$=0.4V | | | −1.6 | mA |
| Logic high-level input current | $I_{IH}$ | $V_{CC}$=5.5V, $V_{IH}$=2.4V | | | +100 | μA |
| Enable low-level input current | $I_{EL}$ | $V_{CC}$=5.5V, $V_{EL}$=0.4V | | | −1.6 | mA |
| Enable high-level input current | $I_{EH}$ | $V_{CC}$=5.5V, $V_{EH}$=2.4V | | | +130 | μA |
| Peak wavelength | $\lambda_{PEAK}$ | $T_A$=25°C | | 655 | | nm |
| Dominant Wavelength (8) | $\lambda_d$ | $T_A$=25°C | | 640 | | nm |
| Weight** | | | | 1.0 | | gm |
| Leak Rate | | | | | $5x10^{-8}$ | cc/sec |

Notes: 1. Nominal thermal resistance of a display mounted in a socket which is soldered into a printed circuit board: $\Theta_{JA}$=50° C/W; $\Theta_{JC}$=15° C/W. 2. $\Theta_{CA}$ of a mounted display should not exceed 35° C/W for operation up to $T_A$=+100° C. 3. Voltage values are with respect to device ground, pin 6. 4. All typical values at $V_{CC}$=5.0 Volts, $T_A$=25° C. 5. These displays are categorized for luminous intensity with the intensity category designated by a letter located on the back of the display contiguous with the Hewlett-Packard logo marking. 6. The luminous intensity at a specific ambient temperature, $I_V(T_A)$, may be calculated from this relationship: $I_V(T_A)=I_{V(25^\circ C)}(.985)^{[T_A-25^\circ C]}$ 7. Applies only to 4N54. 8. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.

*JEDEC Registered Data. **Non Registered Data.

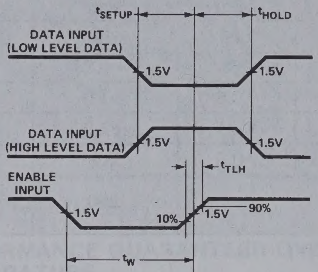
tSETUP
tHOLD
DATA INPUT
(LOW LEVEL DATA)
1.5V
1.5V
DATA INPUT
(HIGH LEVEL DATA)
1.5V
1.5V
tTLH
ENABLE
INPUT
1.5V
10%
1.5V
90%
tW

**Figure 1. Timing Diagram of 4N51-4N54 Series Logic.**

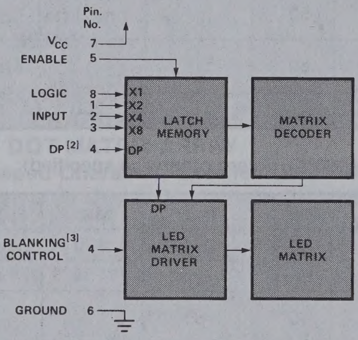
Pin.
No.
VCC 7
ENABLE 5
LOGIC
INPUT
8 X1
1 X2
2 X4
3 X8
DP[2] 4 DP
LATCH
MEMORY
MATRIX
DECODER
DP
BLANKING[3]
CONTROL 4
LED
MATRIX
DRIVER
LED
MATRIX
GROUND 6

**Figure 2. Block Diagram of 4N51-4N54 Series Logic.**

| TRUTH TABLE | | | | | |
|---|---|---|---|---|---|
| BCD DATA[1] | | | | 4N51 AND 4N52 | 4N54 |
| $X_8$ | $X_4$ | $X_2$ | $X_1$ | | |
| L | L | L | L | 0 | 0 |
| L | L | L | H | 1 | 1 |
| L | L | H | L | 2 | 2 |
| L | L | H | H | 3 | 3 |
| L | H | L | L | 4 | 4 |
| L | H | L | H | 5 | 5 |
| L | H | H | L | 6 | 6 |
| L | H | H | H | 7 | 7 |
| H | L | L | L | 8 | 8 |
| H | L | L | H | 9 | 9 |
| H | L | H | L | ▯ | A |
| H | L | H | H | (BLANK) | B |
| H | H | L | L | (BLANK) | C |
| H | H | L | H | - | D |
| H | H | H | L | (BLANK) | E |
| H | H | H | H | (BLANK) | F |
| DECIMAL PT.[2] | | ON | | $V_{DP}$ = L | |
| | | OFF | | $V_{DP}$ = H | |
| ENABLE[1] | | LOAD DATA | | $V_E$ = L | |
| | | LATCH DATA | | $V_E$ = H | |
| BLANKING[3] | | DISPLAY-ON | | $V_B$ = L | |
| | | DISPLAY-OFF | | $V_B$ = H | |

Notes:

1. H = Logic High; L = Logic Low. With the enable input at logic high changes in BCD input logic levels or D.P. input have no effect upon display memory, displayed character, or D.P.
2. The decimal point input, DP, pertains only to the 4N51 and 4N52 displays.
3. The blanking control input, B, pertains only to the 4N54 hexadecimal display. Blanking input has no effect upon display memory.

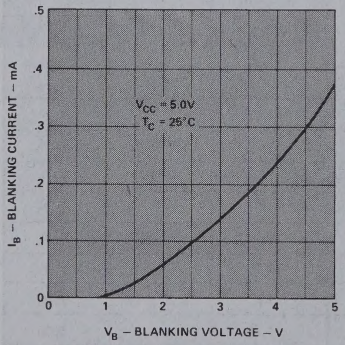

**Figure 3. Typical Blanking Control Current vs. Voltage for 4N54.**

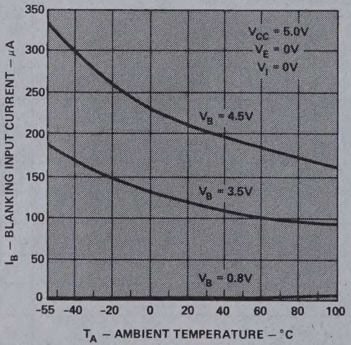

**Figure 4. Typical Blanking Control Input Current vs. Ambient Temperature for 4N54.**

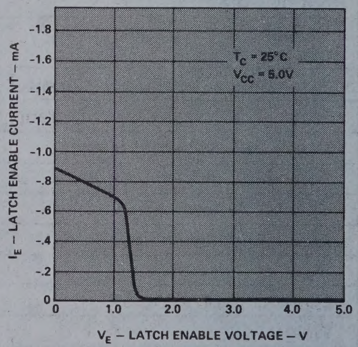

**Figure 5. Typical Latch Enable Input Current vs. Voltage.**

*JEDEC Registered Data.

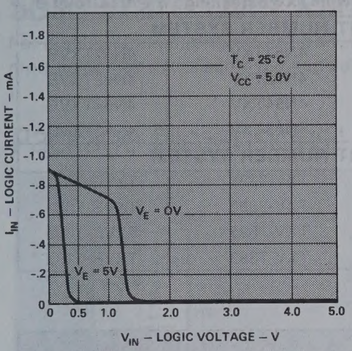

**Figure 6. Typical Logic and Decimal Point Input Current vs. Voltage.**

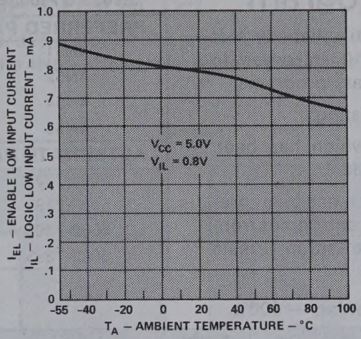

**Figure 7. Typical Logic and Enable Low Input Current vs. Ambient Temperature.**

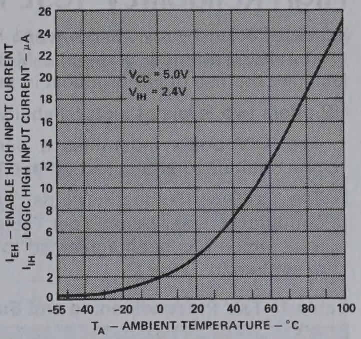

**Figure 8. Typical Logic and Enable High Input Current vs. Ambient Temperature.**

# Operational Considerations

## ELECTRICAL

The 4N51-4N54 series devices use a modified 4 x 7 dot matrix of light emitting diodes (LED's) to display decimal/hexadecimal numeric information. The LED's are driven by constant current drivers. BCD information is accepted by the display memory when the enable line is at logic low and the data is latched when the enable is at logic high. To avoid the latching of erroneous information, the enable pulse rise time should not exceed 200 nanoseconds. Using the enable pulse width and data setup and hold times listed in the Recommended Operating Conditions allows data to be clocked into an array of displays at a 6.7MHz rate.

The blanking control input on the 4N54 display blanks (turns off) the displayed hexadecimal information without disturbing the contents of display memory. The display is blanked at a minimum threshold level of 3.5 volts. This may be easily achieved by using an open collector TTL gate and a pull-up resistor. For example, (1/6) 7416 hexinverter buffer/driver and a 120 ohm pull-up resistor will provide sufficient drive to blank eight displays. The size of the blanking pull-up resistor may be calculated from the following formula, where N is the number of digits:

$$R_{blank} = (V_{CC} - 3.5V)/[N\ (1.0mA)]$$

The decimal point input is active low true and this data is latched into the display memory in the same fashion as is the BCD data. The decimal point LED is driven by the on-board IC.

## MECHANICAL

4N51-4N54 series displays are hermetically tested for use in environments which require a high reliability device. These displays are designed and tested to meet a helium leak rate of 5 x $10^{-8}$ CC/SEC and a standard dye penetrant gross leak test.

These displays may be mounted by soldering directly to a printed circuit board or inserted into a socket. The lead-to-lead pin spacing is 2.54mm (0.100 inch) and the lead row spacing is 15.24mm (0.600 inch). These displays may be end stacked with 2.54mm (0.100 inch) spacing between outside pins of adjacent displays. Sockets such as Augat 324-AG2D (3 digits) or Augat 508-AG8D (one digit, right angle mounting) may be used.

The primary thermal path for power dissipation is through the device leads. Therefore, to insure reliable operation up to an ambient temperature of +100° C, it is important to maintain a case-to-ambient thermal resistance of less than 35° C/watt as measured on top of display pin 3.

Post solder cleaning may be accomplished using water, Freon/alcohol mixtures formulated for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents: Freon TF, Freon TE, Genesolv DI-15, Genesolv DE-15.

## PRECONDITIONING

4N51-4N54 series displays are 100% preconditioned by 24 hour storage at 125° C.

## CONTRAST ENHANCEMENT

The 4N51-4N54 displays have been designed to provide the maximum posible ON/OFF contrast when placed behind an appropriate contrast enhancement filter. Some suggested filters are Panelgraphic Ruby Red 60 and Dark Red 63, SGL Homalite H100-1605, 3M Light Control Film and Polaroid HRCP Red Circular Polarizing Filter. For further information see Hewlett-Packard Application Note 964.

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*JEDEC Registered Data.

# High Reliability Test Program

Hewlett-Packard provides standard high reliability test programs, patterned after MIL-M-38510 in order to facilitate the use of HP products in military programs.

HP offers two levels of high reliability testing:

> The TXV prefix indentifies a part which has been preconditioned and screened per Table 1.
>
> The TXVB prefix identifies a part which has been preconditioned and screened per Table 1, and comes from a lot which has been subjected to the Group B tests described in Table 2.

| Standard Product | With TXV Screening | Plus Group B |
|---|---|---|
| **PREFERRED PART NUMBER SYSTEM** | | |
| 4N51 | 4N51TXV | 4N51TXVB |
| 4N52 | 4N52TXV | 4N52TXVB |
| 4N54 | 4N54TXV | 4N54TXVB |
| 4N53 | 4N53TXV | 4N53TXVB |
| **ALTERNATE PART NUMBER SYSTEM** | | |
| 5082-7391 | TXV-7391 | TXVB-7391 |
| 5082-7392 | TXV-7392 | TXVB-7392 |
| 5082-7395 | TXV-7395 | TXVB-7395 |
| 5082-7393 | TXV-7393 | TXVB-7393 |

**Table 1. TXV Preconditioning and Screening — 100%.**

| Examination or Test | MIL-STD-883 Methods | Conditions |
|---|---|---|
| 1. Internal Visual Inspection | HP Procedure A-5956-7572-52 | |
| 2. Electrical Test: $I_V$, $I_{CC}$, $I_{BL}$, $I_{BH}$, $I_{EL}$, $I_{EH}$, $I_{IL}$, $I_{IH}$. | | Per Electrical/Optical Characterstics. |
| 3. High Temperature Storage | 1008 | 125° C, 168 hours. |
| 4. Temperature Cycling | 1010 | −65° C to +125° C, 10 cycles. |
| 5. Acceleration | 2001 | 2,000 G, $Y_1$ orientation. |
| 6. Helium Leak Test | 1014 | Condition A |
| 7. Gross Leak Test | 1014 | Condition D |
| 8. Electrical Test: Same as Step 2 | | |
| 9. Burn-in | 1015 | $T_A$=100° C, t=168 hours, at $V_{CC}$=5.0V and cycling through logic at 1 character per sec. |
| 10. Electrical Test as in Step 2 | | |
| 11. Sample Electrical Test Over Temperature: $I_{CC}$, $I_{BL}$, $I_{BH}$, $I_{EL}$, $I_{EH}$, $I_{IL}$, $I_{IH}$ | | Per Electrical Characteristics, $T_A$ = -55° C, LTPD = 7 |
| 12. Sample Electrical Test Over Temperature $I_{CC}$, $I_{BL}$, $I_{BH}$, $I_{EL}$, $I_{EH}$, $I_{IL}$, $I_{IH}$ | | Per Electrical Characteristics, $T_A$ = +100° C, LTPD = 7 |
| 13. External Visual | 2009 | |

**Table 2. Group B.**

| Examination or Test | MIL-STD-883 | | LTPD |
|---|---|---|---|
| | Method | Condition | |
| Subgroup 1 | | | 20 |
| Physical Dimensions | 2008 | Package Dimensions per Product Outline Drawing. | |
| Subgroup 2 | | | 15 |
| Solderability | 2003 | Immersion within 0.062" of seating plane 260° C, t=5 sec., omit aging. | |
| Temperature Cycling | 1010 | 10 cycles −65° C to +125° C | |
| Thermal Shock | 1011 | Test Condition A | |
| Hermetic Seal | 1014 | Condition A and Condition D | |
| Moisture Resistance | 1004 | Omit initial conditioning. | |
| End Points: Electrical Test | | Same as Step 2, Table 1. | |
| Subgroup 3 | | | 15 |
| Shock – Non-operating | 2002 | 1500 G, t=0.5ms, 5 blows in each orientation $X_1$, $Y_1$, $Y_2$. | |
| Vibration Variable Frequency | 2007 | Non-operating. | |
| Constant Acceleration | 2001 | 2,000 G, $Y_1$ orientation. | |
| End Points: Electrical Test | | Same as Step 2, Table 1. | |
| Subgroup 4 | | | 15 |
| Terminal Strength | 2004 | Test Condition B2. | |
| End Points: Hermetic Seal | 1014 | Condition A and Condition D | |
| Subgroup 5 | | | 15 |
| Salt Atmosphere | 1009 | Test Condition A | |
| Subgroup 6 | | | λ=7 |
| High Temperature Life | 1008 | $T_A$= 125° C, non-operating, t=1000 hours. | |
| End Points: Electrical Test | | Same as Step 2, Table 1. | |
| Subgroup 7 | | | λ=5 |
| Steady State Operating Life | 1005 | $T_A$=100° C, t=1000 hours, at $V_{CC}$=5.0V and cycling through logic at 1 character per second. | |
| End Points: Electrical Test | | Same as Step 2, Table 1. | |

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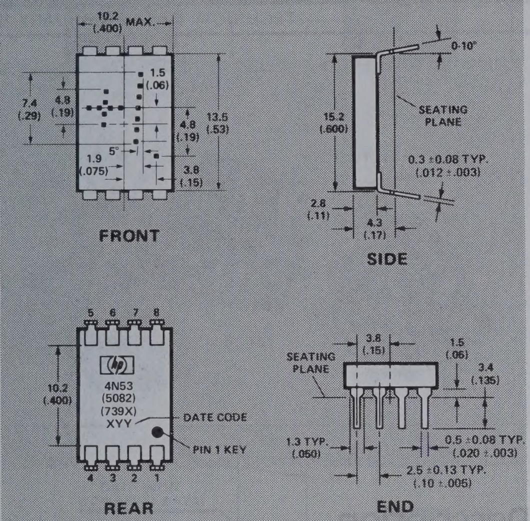
*JEDEC Registered Data.

# Solid State Over Range Character

For display applications requiring a +, 1, or decimal point designation, the 4N53 over range character is available. This display module comes in the same package as the 4N51-4N54 series numeric indicator and is completely compatible with it.

## Package Dimensions*


10.2 (.400) MAX.
1.5 (.06)
7.4 (.29)
4.8 (.19)
4.8 (.19)
13.5 (.53)
5°
1.9 (.075)
3.8 (.15)
FRONT
0-10°
SEATING PLANE
15.2 (.600)
0.3 ±0.08 TYP. (.012 ±.003)
2.8 (.11)
4.3 (.17)
SIDE
5 6 7 8
10.2 (.400)
4N53
(5082)
(739X)
XYY
DATE CODE
PIN 1 KEY
4 3 2 1
REAR
SEATING PLANE
3.8 (.15)
1.5 (.06)
3.4 (.135)
1.3 TYP. (.050)
0.5 ±0.08 TYP. (.020 ±.003)
2.5 ±0.13 TYP. (.10 ±.005)
END

NOTES:
1. DIMENSIONS IN MILLIMETRES AND (INCHES).
2. UNLESS OTHERWISE SPECIFIED, THE TOLERANCE ON ALL DIMENSIONS IS ±.38 MM (± .015 INCHES).

| PIN | FUNCTION |
|---|---|
| 1 | Plus |
| 2 | Numeral One |
| 3 | Numeral One |
| 4 | DP |
| 5 | Open |
| 6 | Open |
| 7 | $V_{cc}$ |
| 8 | Minus/Plus |

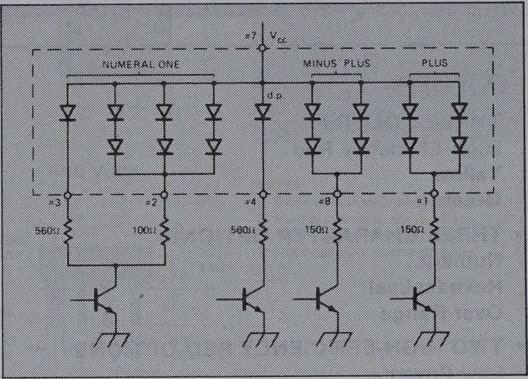

#7
$V_{cc}$
NUMERAL ONE
MINUS PLUS
PLUS
d.p.
#3
#2
#4
#8
#1
560Ω
100Ω
560Ω
150Ω
150Ω

Figure 9. Typical Driving Circuit.

### TRUTH TABLE

| CHARACTER | PIN | | | |
|---|---|---|---|---|
| | 1 | 2,3 | 4 | 8 |
| + | H | X | X | H |
| – | L | X | X | H |
| 1 | X | H | X | X |
| Decimal Point | X | X | H | X |
| Blank | L | L | L | L |

NOTES:
L: Line switching transistor in Figure 9 cutoff.
H: Line switching transistor in Figure 9 saturated.
X: 'Don't care'

## Electrical/Optical Characteristics*

**4N53** ($T_A$ = –55°C to +100°C, Unless Otherwise Specified)

| DESCRIPTION | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Forward Voltage per LED | $V_F$ | $I_F$ = 10 mA | | 1.6 | 2.0 | V |
| Power dissipation | $P_T$ | $I_F$ = 10 mA<br>all diodes lit | | 280 | 320 | mW |
| Luminous Intensity per LED (digit average) | $I_v$ | $I_F$ = 6 mA<br>$T_C$ = 25°C | 40 | 85 | | µcd |
| Peak wavelength | $\lambda_{peak}$ | $T_C$ = 25°C | | 655 | | nm |
| Dominant Wavelength | $\lambda d$ | $T_C$ = 25°C | | 640 | | nm |
| Weight ** | | | | 1.0 | | gm |

## Recommended Operating Conditions*

| | SYMBOL | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| LED supply voltage | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| Forward current, each LED | $I_F$ | | 5.0 | 10 | mA |

NOTE:
LED current must be externally limited. Refer to Figure 9 for recommended resistor values.

*JEDEC Registered Data. **Non Registered Data.

## Absolute Maximum Ratings*

| DESCRIPTION | SYMBOL | MIN. | MAX. | UNIT |
|---|---|---|---|---|
| Storage temperature, ambient | $T_S$ | -65 | +125 | °C |
| Operating temperature, ambient | $T_A$ | -55 | +100 | °C |
| Forward current, each LED | $I_F$ | | 10 | mA |
| Reverse voltage, each LED | $V_R$ | | 4 | V |

HEWLETT
PACKARD

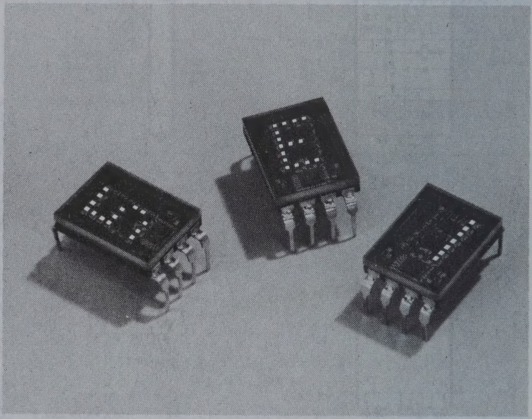
# HIGH EFFICIENCY RED, YELLOW, AND GREEN NUMERIC AND HEXADECIMAL DISPLAYS FOR INDUSTRIAL APPLICATIONS

HDSP-0760
HDSP-0770
HDSP-0860
HDSP-0960
SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **THREE COLORS**
  **High-Efficiency Red**
  **Yellow**
  **Green**
- **THREE CHARACTER OPTIONS**
  **Numeric**
  **Hexadecimal**
  **Over Range**
- **TWO HIGH-EFFICIENCY RED OPTIONS**
  **Low Power**
  **High Brightness**
- **PERFORMANCE GUARANTEED OVER TEMPERATURE**
- **MEMORY LATCH/DECODER/DRIVER**
  **TTL Compatible**
- **4x7 DOT MATRIX CHARACTER**
- **CATEGORIZED FOR LUMINOUS INTENSITY YELLOW AND GREEN CATEGORIZED FOR COLOR**
  **Use of Like Categories Yields a Uniform Display**



## Description

These solid state display devices are designed and tested for use in adverse industrial environments. The character height is 7.4mm (0.29 inch). The numeric and hexadecimal devices incorporate an on-board IC that contains the data memory, decoder and display driver functions.

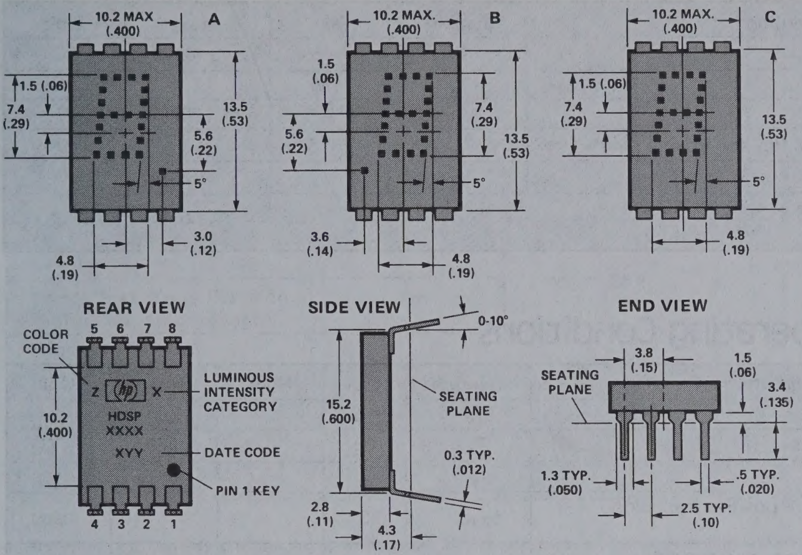
The numeric devices decode positive BCD logic into characters "0-9", a "—" sign, decimal point, and a test pattern. The hexadecimal devices decode positive BCD logic into 16 characters, "0-9, A-F". An input is provided on the hexadecimal devices to blank the display (all LED's off) without losing the contents of the memory.

The over range device displays "±1" and right hand decimal point and is typically driven via external switching transistors.

## Devices

| Part Number HDSP- | Color | Description | Front View |
|---|---|---|---|
| 0760 | High-Efficiency Red Low Power | Numeric, Right Hand DP | A |
| 0761 | | Numeric, Left Hand DP | B |
| 0762 | | Hexadecimal | C |
| 0763 | | Over Range ±1 | D |
| 0770 | High-Efficiency Red High Brightness | Numeric, Right Hand DP | A |
| 0771 | | Numeric, Left Hand DP | B |
| 0772 | | Hexadecimal | C |
| 0763 | | Over Range ±1 | D |
| 0860 | Yellow | Numeric, Right Hand DP | A |
| 0861 | | Numeric, Left Hand DP | B |
| 0862 | | Hexadecimal | C |
| 0863 | | Over Range ±1 | D |
| 0960 | Green | Numeric, Right Hand DP | A |
| 0961 | | Numeric, Left Hand DP | B |
| 0962 | | Hexadecimal | C |
| 0963 | | Over Range ±1 | D |

# Package Dimensions


10.2 MAX (.400)
A
B
C
1.5 (.06)
7.4 (.29)
13.5 (.53)
5.6 (.22)
5°
3.0 (.12)
3.6 (.14)
4.8 (.19)
REAR VIEW
COLOR CODE
5 6 7 8
4 3 2 1
Z
X
HDSP
XXXX
XYY
10.2 (.400)
LUMINOUS INTENSITY CATEGORY
DATE CODE
PIN 1 KEY
SIDE VIEW
0-10°
SEATING PLANE
15.2 (.600)
0.3 TYP. (.012)
2.8 (.11)
4.3 (.17)
END VIEW
3.8 (.15)
1.5 (.06)
3.4 (.135)
1.3 TYP. (.050)
.5 TYP. (.020)
2.5 TYP. (.10)

| PIN | FUNCTION | |
|---|---|---|
| | NUMERIC | HEXA-DECIMAL |
| 1 | Input 2 | Input 2 |
| 2 | Input 4 | Input 4 |
| 3 | Input 8 | Input 8 |
| 4 | Decimal point | Blanking control |
| 5 | Latch enable | Latch enable |
| 6 | Ground | Ground |
| 7 | $V_{CC}$ | $V_{CC}$ |
| 8 | Input 1 | Input 1 |

NOTES:
1. Dimensions in millimetres and (inches).
2. Vertical digit center line is ± .51mm (± .02") from vertical package center line.
3. HDSP-0860 and HDSP-0960 Series.

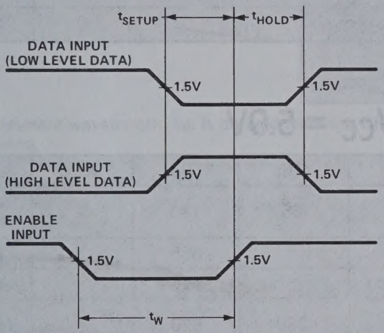

$t_{SETUP}$
$t_{HOLD}$
DATA INPUT (LOW LEVEL DATA)
1.5V
1.5V
DATA INPUT (HIGH LEVEL DATA)
1.5V
1.5V
ENABLE INPUT
1.5V
1.5V
$t_W$

**Figure 1. Timing Diagram**

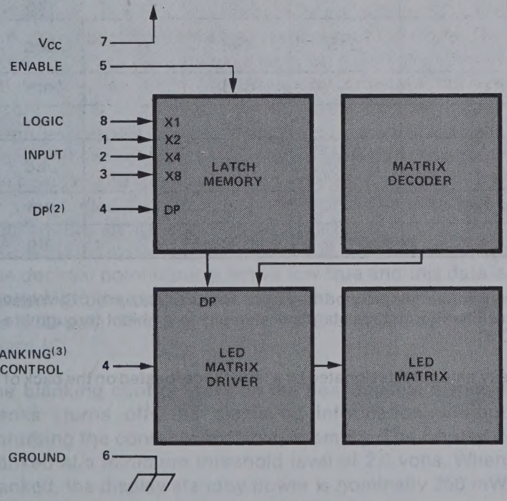

$V_{CC}$ 7
ENABLE 5
LOGIC INPUT
8 X1
1 X2
2 X4
3 X8
LATCH MEMORY
MATRIX DECODER
DP(2) 4 DP
DP
BLANKING(3) CONTROL 4
LED MATRIX DRIVER
LED MATRIX
GROUND 6

**Figure 2. Logic Block Diagram**

| TRUTH TABLE | | | | | |
|---|---|---|---|---|---|
| BCD DATA[1] | | | | NUMERIC | HEXA-DECIMAL |
| $X_8$ | $X_4$ | $X_2$ | $X_1$ | | |
| L | L | L | L | 0 | 0 |
| L | L | L | H | 1 | 1 |
| L | L | H | L | 2 | 2 |
| L | L | H | H | 3 | 3 |
| L | H | L | L | 4 | 4 |
| L | H | L | H | 5 | 5 |
| L | H | H | L | 6 | 6 |
| L | H | H | H | 7 | 7 |
| H | L | L | L | 8 | 8 |
| H | L | L | H | 9 | 9 |
| H | L | H | L | □ | A |
| H | L | H | H | (BLANK) | B |
| H | H | L | L | (BLANK) | C |
| H | H | L | H | - | D |
| H | H | H | L | (BLANK) | E |
| H | H | H | H | (BLANK) | F |
| DECIMAL PT.[2] | | ON | | $V_{DP}$ = L | |
| | | OFF | | $V_{DP}$ = H | |
| ENABLE[1] | | LOAD DATA | | $V_E$ = L | |
| | | LATCH DATA | | $V_E$ = H | |
| BLANKING[3] | | DISPLAY-ON | | $V_B$ = L | |
| | | DISPLAY-OFF | | $V_B$ = H | |

Notes:
1. H = Logic High; L = Logic Low. With the enable input at logic high changes in BCD input logic levels have no effect upon display memory, displayed character, or DP.
2. The decimal point input, DP, pertains only to the numeric displays.
3. The blanking control input, B, pertains only to the hexadecimal displays. Blanking input has no effect upon display memory.

## Absolute Maximum Ratings

| Description | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage temperature, ambient | $T_S$ | −65 | +100 | °C |
| Operating temperature, ambient [1] | $T_A$ | −55 | +70 | °C |
| Supply voltage [2] | $V_{CC}$ | −0.5 | +7.0 | V |
| Voltage applied to input logic, dp and enable pins | $V_I, V_{DP}, V_E$ | −0.5 | $V_{CC}$ | V |
| Voltage applied to blanking input [2] | $V_B$ | −0.5 | $V_{CC}$ | V |
| Maximum solder temperature at 1.59mm (.062 inch) below seating plane; $t \leqslant 5$ seconds | | | 260 | °C |

## Recommended Operating Conditions

| Description | Symbol | Min. | Nom. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage [2] | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| Operating temperature, ambient [1] | $T_A$ | -55 | | +70 | °C |
| Enable Pulse Width | $t_W$ | 100 | | | nsec |
| Time data must be held before positive transition of enable line | $t_{SETUP}$ | 50 | | | nsec |
| Time data must be held after positive transition of enable line | $t_{HOLD}$ | 50 | | | nsec |
| Enable pulse rise time | $t_{TLH}$ | | | 1.0 | msec |

## Optical Characteristics at $T_A = 25°C$, $V_{CC} = 5.0V$

| Device | Description | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| HDSP-0760 Series | Luminous Intensity per LED (Digit Average) [3,4] | Iv | 65 | 140 | | μcd |
| | Peak Wavelength | λPEAK | | 635 | | nm |
| | Dominant Wavelength [5] | λd | | 626 | | nm |
| HDSP-0770 Series | Luminous Intensity per LED (Digit Average) [3,4] | Iv | 260 | 620 | | μcd |
| | Peak Wavelength | λPEAK | | 635 | | nm |
| | Dominant Wavelength [5] | λd | | 626 | | nm |
| HDSP-0860 Series | Luminous Intensity per LED (Digit Average) [3,4] | Iv | 215 | 490 | | μcd |
| | Peak Wavelength | λPEAK | | 583 | | nm |
| | Dominant Wavelength [5,6] | λd | | 585 | | nm |
| HDSP-0960 Series | Luminous Intensity per LED (Digit Average) [3,4] | Iv | 170 | 390 | | μcd |
| | Peak Wavelength | λPEAK | | 565 | | nm |
| | Dominant Wavelength [5,6] | λd | | 572 | | nm |

Notes:

1. The nominal thermal resistance of a display mounted in a socket that is soldered onto a printed circuit board is $R\theta_{JA} = 50°C/W$/device. The device package thermal resistance is $R\theta_{J\text{-}PIN} = 15°C/W$/device. The thermal resistance device pin-to-ambient through the PC board should not exceed 35°C/W/device for operation at $T_A = +70°C$.
2. Voltage values are with respect to device ground, pin 6.
3. These displays are categorized for luminous intensity with the intensity category designated by a letter code located on the back of the display package.

# Electrical Characteristics; $T_A = 0°C$ to $+70°C$

| Description | | Symbol | Test Conditions | Min. | Typ.[7] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Supply Current | HDSP-0760 Series | $I_{CC}$ | $V_{CC} = 5.5V$ (Numeral 5 and DP Illuminated) | | 78 | 105 | mA |
| | HDSP-0770 Series<br>HDSP-0860 Series<br>HDSP-0960 Series | | | | 120 | 175 | |
| Power Dissipation | HDSP-0760 Series | $P_T$ | $V_{CC} = 5.5V$ (Numeral 5 and DP Illuminated) | | 390 | 573 | mW |
| | HDSP-0770 Series<br>HDSP-0860 Series<br>HDSP-0960 Series | | | | 690 | 963 | |
| Logic, Enable and Blanking Low-Level Input Voltage | | $V_{IL}$ | $V_{CC} = 4.5V$ | | | 0.8 | V |
| Logic, Enable and Blanking High-Level Input Voltage | | $V_{IH}$ | | 2.0 | | | V |
| Logic and Enable Low-Level Input Current | | $I_{IL}$ | $V_{CC} = 5.5V$ | | | -1.6 | mA |
| Blanking Low-Level Input Current | | $I_{BL}$ | $V_{IL} = 0.4V$ | | | -10 | µA |
| Logic, Enable and Blanking High-Level Input Current | | $I_{IH}$ | $V_{CC} = 5.5V$<br>$V_{IH} = 2.4V$ | | | +40 | µA |
| Weight | | | | | 1.0 | | gm |

Notes:

4. The luminous intensity at a specific operating ambient temperature, $I_V(T_A)$ may be calculated from the following expotential equation: $I_V(T_A) = I_V(25°C)\, e^{[k(T_A - 25°C)]}$

| Device | K |
|---|---|
| HDSP-0760 Series<br>HDSP-0770 Series | -0.0131/°C |
| HDSP-0860 Series | -0.0112/°C |
| HDSP-0960 Series | -0.0104/°C |

5. The dominant wavelength, $\lambda_d$, is derived from the CIE Chromaticity Diagram and is that single wavelength which defines the color of the device.
6. The HDSP-0860 and HDSP-0960 series devices are categorized as to dominant wavelength with the category designated by a number on the back side of the display package.
7. All typical values at $V_{CC} = 5.0V$ and $T_A = 25°C$.

# Operational Considerations

## ELECTRICAL

These devices use a modified 4 x 7 dot matrix of light emitting diode to display decimal/hexadecimal numeric information. The high efficiency red and yellow LED's are GaAsP epitaxial layer on a GaP transparent substrate. The green LED's are GaP epitaxial layer on a GaP transparent substrate. The LED's are driven by constant current drivers, BCD information is accepted by the display memory when the enable line is at logic low and the data is latched when the enable is at logic high. Using the enable pulse width and data setup and hold times listed in the Recommended Operating Conditions allows data to be clocked into an array of displays at a 6.7 MHz rate.

The decimal point input is active low true and this data is latched into the display memory in the same fashion as is the BCD data. The decimal point LED is driven by the on-board IC.

The blanking control input on the hexadecimal displays blanks (turns off) the displayed information without disturbing the contents of display memory. The display is blanked at a minimum threshold level of 2.0 volts. When blanked, the display standby power is nominally 250 mW at $T_A = 25°C$.

## MECHANICAL

The primary thermal path for power dissipation is through the device leads. Therefore, to insure reliable operation up to an ambient temperature of +70°C, it is important to maintain a base-to-ambient thermal resistance of less than 35°C watt/device as measured on top of display pin 3.

Post solder cleaning may be accomplished using water, Freon/alcohol mixtures formulated for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixutres formulated for room temperature cleaning. Suggested solvents: Freon TF, Freon TE, Genesolv DI-15, Genesolv DE-15.

## CONTRAST ENHANCEMENT

These display devices are designed to provide an optimum ON/OFF contrast when placed behind an appropriate contrast enhancement filter. The following filters are suggested:

### HIGH EFFICIENCY RED

Panelgraphic Scarlet Red 65
SGL Homalite H100-1670
3M Louvered Filter R6310

**YELLOW**

Panelgraphic Yellow 27
SGL Homalite H100-1720
3M Louvered Filter A5910

**GREEN**

Panelgraphic Green 48
SGL Homalite H100-1440
3M Louvered Filter G5610

For many applications a neutral density gray filter in either plastic, circular polarizer or optically coated glass will provide the needed contrast enhancement. Suggested plastic neutral density gray filters are Panelgraphic Gray 10, SGL Homalite H100-1266 or 3M N0220. The optically coated glass/ circular polarized SUNGARD filter by Optical Coating Laboratory, Inc., or the HNCP10 filter by Polaroid, provides superior contrast enhancement for very bright ambients.

# Over Range Character

The over range devices display "±1" and decimal point. The character height and package configuration are the same as the numeric and hexadecimal devices. Character selection is obtained via external switching transistors and current limiting resistors.

# Absolute Maximum Ratings

| Description | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage Temperature, Ambient | $T_S$ | -65 | +100 | °C |
| Operating Temperature Ambient | $T_A$ | -55 | +70 | °C |
| Forward Current, Each LED | $I_F$ |  | 10 | mA |
| Reverse Voltage, Each LED | $V_R$ |  | 5 | V |

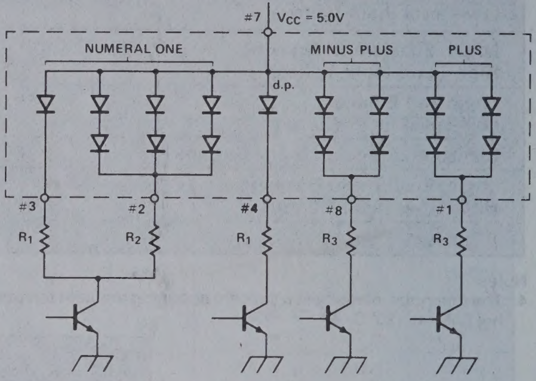
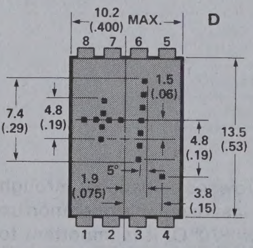


Figure 3. Typical Driving Circuit

# Package Dimensions



FRONT VIEW

Note:
1. Dimensions in millimetres and (inches).

| Pin | Function |
|---|---|
| 1 | Plus |
| 2 | Numeral One |
| 3 | Numeral One |
| 4 | DP. |
| 5 | Open |
| 6 | Open |
| 7 | Vcc |
| 8 | Minus/Plus |

| Character | Pin |  |  |  |
|---|---|---|---|---|
|  | 1 | 2,3 | 4 | 8 |
| + | 1 | X | X | 1 |
| — | 0 | X | X | 1 |
| 1 | X | 1 | X | X |
| Decimal Point | X | X | 1 | X |
| Blank | 0 | 0 | 0 | 0 |

Notes:
0: Line switching transistor in Figure 7 cutoff.
1: Line switching transistor in Figure 7 saturated.
X: 'don't care'

# Recommended Operating Conditions $V_{CC} = 5.0V$

| Device |  | Forward Current Per LED, mA | Resistor Value |  |  |
|---|---|---|---|---|---|
|  |  |  | $R_1$ | $R_2$ | $R_3$ |
| HDSP-0763 | Low Power | 2.3 | 1100 | 200 | 270 |
|  | High Brightness | 8 | 400 | 130 | 200 |
| HDSP-0863 |  | 8 | 360 | 120 | 180 |
| HDSP-0963 |  | 8 | 330 | 100 | 160 |

# Luminous Intensity Per LED

(Digit Average) at $T_A = 25°C$

| Device | Test Conditions | Min. | Typ. | Units |
|---|---|---|---|---|
| HDSP-0763 | $I_F = 2.3$ mA | 65 | 140 | μcd |
|  | $I_F = 8$ mA |  | 620 | μcd |
| HDSP-0863 | $I_F = 8$ mA | 215 | 490 | μcd |
| HDSP-0963 | $I_F = 8$ mA | 170 | 390 | μcd |

# Electrical Characteristics; $T_A = 0°C$ to $+70°C$

| Device | Description | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| HDSP-0763 | Power Dissipation (all LED's Illuminated) | $P_T$ | $I_F = 2.8$ mA | | 72 | | mW |
| | | | $I_F = 8$ mA | | 224 | 282 | |
| | Forward Voltage per LED | $V_F$ | $I_F = 2.8$ mA | | 1.6 | | V |
| | | | $I_F = 8$ mA | | 1.75 | 2.2 | |
| HDSP-0863 | Power Dissipation (all LED's Illuminated) | $P_T$ | $I_F = 8$ mA | | 237 | 282 | mW |
| | Forward Voltage per LED | $V_F$ | | | 1.90 | 2.2 | V |
| HDSP-0963 | Power Dissipation (all LED's Illuminated) | $P_T$ | $I_F = 8$ mA | | 243 | 282 | mW |
| | Forward Voltage per LED | $V_F$ | | | 1.85 | 2.2 | V |

**HEWLETT PACKARD**

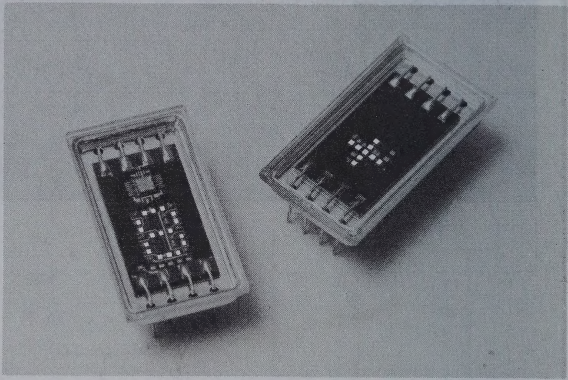
# SOLID STATE NUMERIC INDICATOR

## 5082-7010
## 5082-7011

TECHNICAL DATA FEBRUARY 1982

## Features

- **RUGGED, SHOCK RESISTANT**
- **DESIGNED TO MEET MIL STANDARDS**
- **INCLUDES DECODER/DRIVER**
  - **BCD Inputs**
- **TTL/DTL COMPATIBLE**
- **CONTROLLABLE LIGHT OUTPUT**
- **5 x 7 LED MATRIX CHARACTER**



## Description

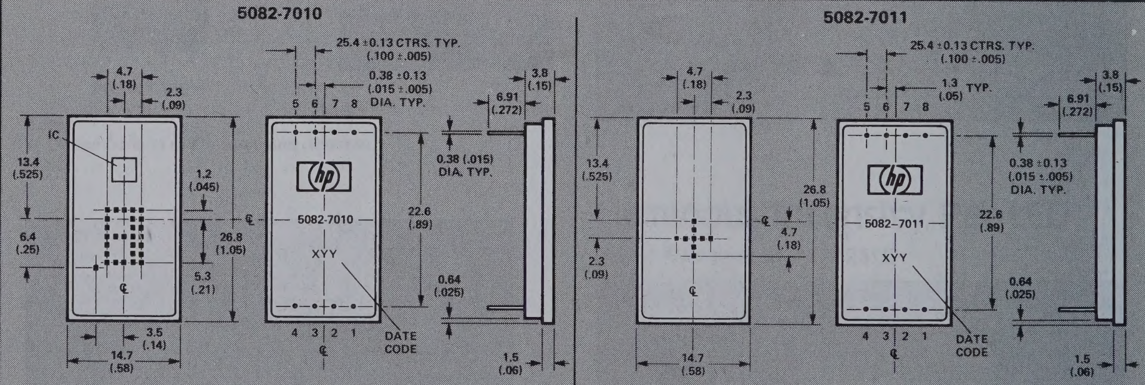
The HP 5082-7010 solid state numeric indicator with built-in decoder/driver provides an excellent 6.8mm (0.27 in.) display for use in military or adverse industrial environments. Typical applications include ground, airborne and shipboard equipment, fire control systems, medical instruments, and space flight systems.

The 5082-7010 is a modified 5x7 matrix display that indicates the numerals 0-9 when presented with a BCD code. The BCD code is negative logic with blanks displayed for invalid codes. A left-hand decimal point is included which must be externally current limited.

The 5082-7011 is a companion plus/minus sign in the same type package. Plus/minus indications require only that voltage be applied to two input pins.

Both displays allow luminous intensity to be varied by changing the DC drive voltage or by pulse duration modulation of the LED voltage.

## Package Dimensions


5082-7010
5082-7011
25.4 ±0.13 CTRS. TYP. (.100 ±.005)
0.38 ±0.13 (.015 ±.005) DIA. TYP.
4.7 (.18)
2.3 (.09)
3.8 (.15)
6.91 (.272)
IC
13.4 (.525)
1.2 (.045)
6.4 (.25)
26.8 (1.05)
5.3 (.21)
3.5 (.14)
14.7 (.58)
22.6 (.89)
0.38 (.015) DIA. TYP.
0.64 (.025)
1.5 (.06)
5082-7010
5082-7011
XYY
DATE CODE
5 6 7 8
4 3 2 1
℄
2.3 (.09)

**5082-7010**

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | Input 1 | 5 | Input 4 |
| 2 | $V_{DP}$ | 6 | Ground |
| 3 | $V_{LED}$ | 7 | $V_{CC}$ |
| 4 | Input 8 | 8 | Input 2 |

**5082-7011**

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | NC | 5 | NC |
| 2 | NC | 6 | Ground |
| 3 | Plus | 7 | Minus/Plus |
| 4 | NC | 8 | NC |

**Notes:**
1. Unless otherwise specified, the tolerance on all dimensions is ±0.38 mm. (±0.015 inches).
2. All dimensions in millimetres and (inches).
3. The package and mounting pins are tin plated Kovar.

# Absolute Maximum Ratings

| Description | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage Temperature, Ambient | $T_S$ | –65 | +100 | °C |
| Operating Temperature, Case | $T_C$ | –55 | +95 | °C |
| Logic Supply Voltage to Ground | $V_{CC}$ | –0.5 | +7.0 | V |
| Logic Input Voltage | $V_I$ | –0.5 | +5.5 | V |
| LED Supply Voltage to Ground | $V_{LED}$[1] | –0.5 | +5.5 | V |
| Decimal Point Current | $I_{DP}$ | | –10 | mA |

Note: 1. Above $T_C$ = 65°C derate $V_{LED}$ per derating curve in Figure 10.

# Recommended Operating Conditions

| Description | Symbol | Min. | Nom. | Max. | Unit |
|---|---|---|---|---|---|
| Logic Supply Voltage | $V_{CC}$ | 4.5 | 5.0 | 5.5 | V |
| LED Supply Voltage, Display Off | $V_{LED}$ | –0.5 | 0 | +1.0 | V |
| LED Supply Voltage, Display On | $V_{LED}$ | 3.0 | 4.2 | 5.5 | V |
| Decimal Point Current | $I_{DP}$[2] | 0 | –5.0 | –10.0 | mA |
| Logic Input Voltage, "H" State | $V_{IH}$ | 2.0 | | 5.5 | V |
| Logic Input Voltage, "L" State | $V_{IL}$ | 0 | | 0.8 | V |

Note: 2. Decimal point current must be externally current limited. See application information.

# Electrical /Optical Characteristics

Case Temperature, $T_C$ = 0°C to 70°C, unless otherwise specified

| Description | Symbol | Test Conditions | | Min. | Typ.[4] | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Logic Supply Current | $I_{CC}$ | $V_{CC}$ = 5.5V | | | 45 | 75 | mA |
| LED Supply Current | $I_{LED}$ [3] [5] | $V_{CC}$ | $V_{LED}$ | | | | mA |
| | | 5.5V | 5.5V | | 255 | 350 | |
| | | 5.5V | 4.2V | | 170 | 235 | |
| | | 5.5V | 3.5V | | 125 | | |
| Logic Input Current, "H" State (ea. input) | $I_{IH}$ | $V_{CC}$ = 5.5V<br>$V_{IH}$ = 2.4V | | | | 100 | µA |
| Logic Input Current, "L" State (ea. input) | $I_{IL}$ | $V_{CC}$ = 5.5V<br>$V_{IL}$ = 0.4V | | | | –1.6 | mA |
| Decimal Point Voltage Drop | $V_{LED} - V_{DP}$ | $I_{DP}$ = –10mA | | | 1.6 | 2.0 | V |
| Power Dissipation | $P_T$ [3] [5] | $V_{CC}$ | $V_{LED}$ | | | | W |
| | | 5.5V | 5.5V | | 1.7 | 2.3 | |
| | | 5.5V | 4.2V | | 1.0 | 1.4 | |
| | | 5.5V | 3.5V | | 0.7 | | |
| Luminous Intensity per LED (digit avg.) | $I_v$ | $V_{LED}$ | $T_C$ | | | | µcd |
| | | 5.5V | 25°C | 60 | 115 | | |
| | | 4.2V | 25°C | 40 | 80 | | |
| | | 3.5V | 25°C | | 50 | | |
| Peak Wavelength | $\lambda_{peak}$ | | | | 655 | | nm |
| Spectral Halfwidth | $\Delta\lambda_{1/2}$ | | | | 30 | | nm |
| Weight | | | | | 4.9 | | gram |

Notes: 3. With numeral 8 displayed.
4. All typical values at $T_C$ = 25°C.
5. $T_C$ = 0°C to 65°C for $V_{LED}$ = 5.5V.

# Truth Table

| Character | Logic X8 | Logic X4 | Logic X2 | Logic X1 | |
|---|---|---|---|---|---|
| 0 | H | H | H | H | 0 |
| 1 | H | H | H | L | 1 |
| 2 | H | H | L | H | 2 |
| 3 | H | H | L | L | 3 |
| 4 | H | L | H | H | 4 |
| 5 | H | L | H | L | 5 |
| 6 | H | L | L | H | 6 |
| 7 | H | L | L | L | 7 |
| 8 | L | H | H | H | 8 |
| 9 | L | H | H | L | 9 |
| Blank | L | H | L | H | |
| Blank | L | H | L | L | |
| Blank | L | L | H | H | |
| Blank | L | L | H | L | |
| Blank | L | L | L | H | |
| Blank | L | L | L | L | |

$V_{IL}$ = 0.0 to 0.8V
$V_{IH}$ = 2.0 to 5.5V

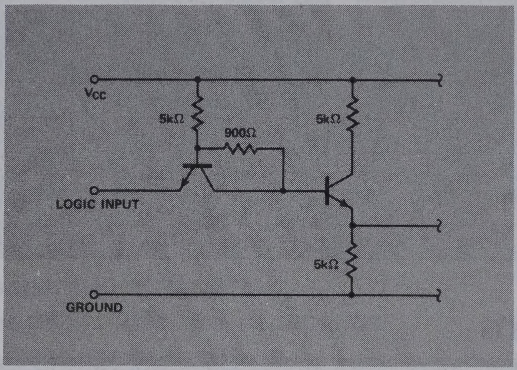

VCC
5kΩ
900Ω
5kΩ
LOGIC INPUT
5kΩ
GROUND

Figure 1. Equivalent input circuit of the 5082-7010 decoder. Note: Display metal case is isolated from ground pin #6.

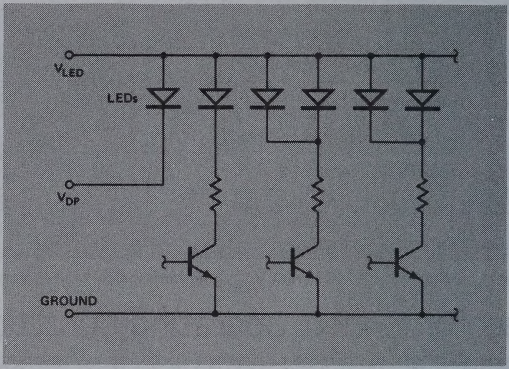

VLED
LEDs
VDP
GROUND

Figure 2. Equivalent circuit of the 5082-7010 as seen from LED and decimal point drive lines.

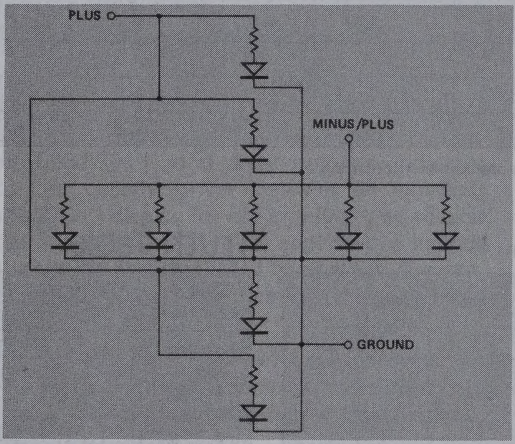

PLUS
MINUS/PLUS
GROUND

Figure 3. Equivalent circuit of 5082-7011 plus/minus sign. All resistors 345Ω typical. Note: Display metal case is isolated from ground pin #6.

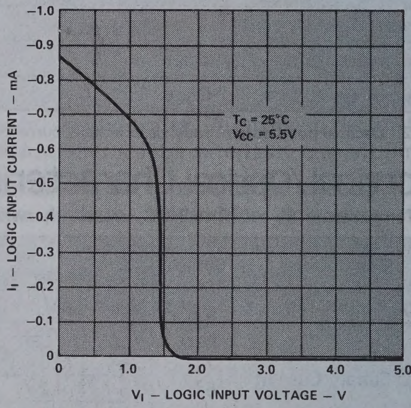


Figure 4. Input current as a function of input voltage, each input.

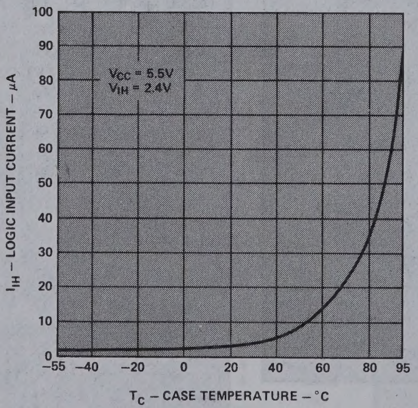


Figure 5. Logic "H" input current as a function of case temperature, each input.

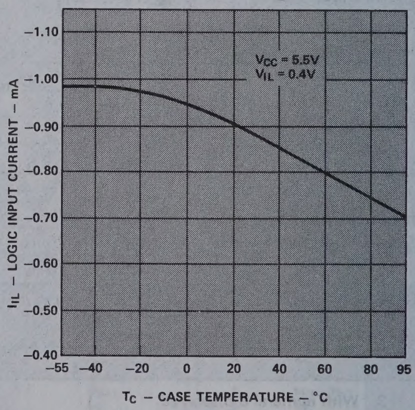


Figure 6. Logic "L" input current as a function of case temperature, each input.

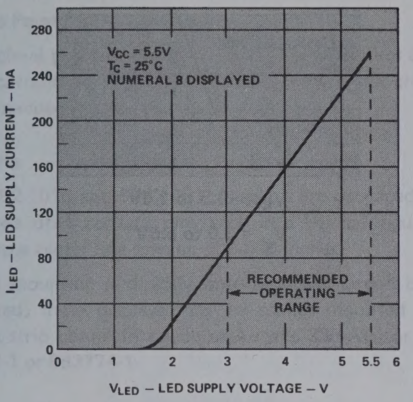


Figure 7. LED supply current as a function of LED supply voltage.

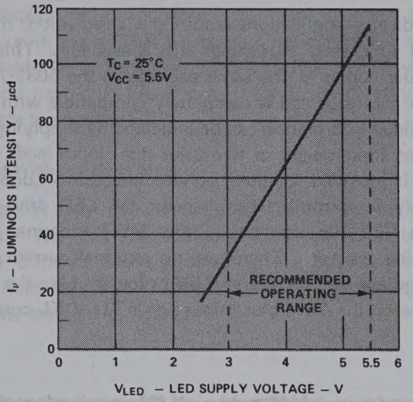


Figure 8. Luminous intensity per LED (digit average) as a function of LED supply voltage.

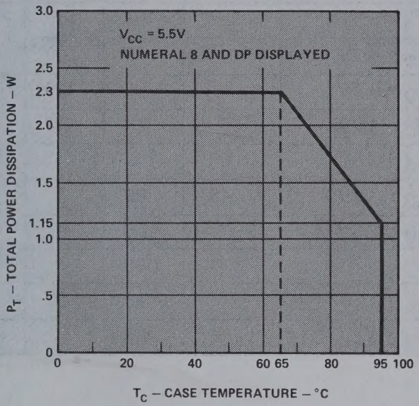


Figure 9. Maximum power derating as a function of case temperature.

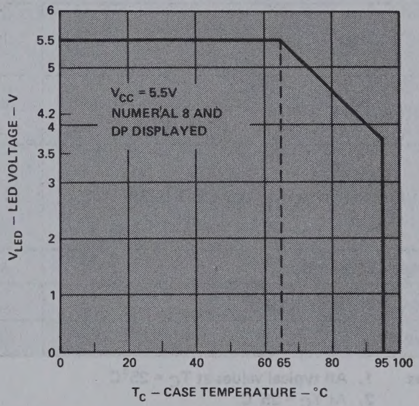


Figure 10. LED voltage derating as a function of case temperature.

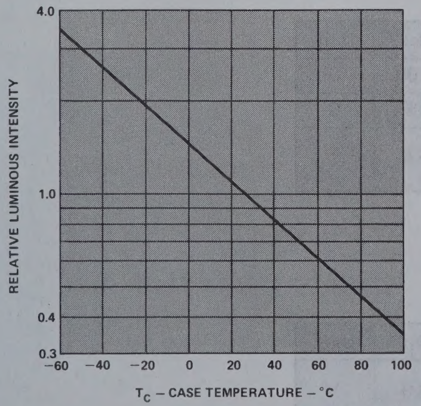


Figure 11. Relative luminous intensity as a function of case temperature at fixed current level.

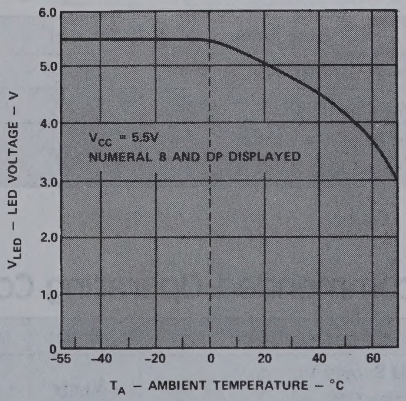


Figure 12. LED voltage derating as a function of ambient temperature, display soldered into P.C. board without heat sink.

# Solid State Plus/Minus Sign

For display applications requiring ± designation, the 5082-7011 solid state plus/minus sign is available. This display module comes in the same package as the 5082-7010 numeric indicator and is completely compatible with it. Plus or minus information can be indicated by supplying voltage to one (minus sign) or two (plus sign) input leads. A third lead is provided for the ground connection. Luminous intensity is controlled by changing the LED drive voltage. Each LED has its own built-in 345Ω (nominal) current limiting resistor. Therefore, no external current limiting is required for voltages at 5.5V or lower. Like the numeric indicator, the -7011 plus/minus sign is TTL/DTL compatible.

# Truth Table

| CHARACTER | PIN | |
|---|---|---|
| | 3 | 7 |
| + | H | H |
| – | L | H |
| Blank | L | L |

**$V_L$ = –0.5 to 1.0V**

**$V_H$ = 3.0 to 5.5V**

# Electrical /Optical Characteristics

**Case Temperature, $T_C$ = 0°C to 70°C, unless otherwise specified**

| Description | Symbol | Test Conditions | Min. | Typ.[1] | Max. | Unit |
|---|---|---|---|---|---|---|
| LED Supply Current | $I_{LED}$ | $V_{LED}$ = 5.5V | | 105 | 150 | mA |
| | | $V_{LED}$ = 4.2V | | 70 | 100 | |
| Power Dissipation | $P_T$ | $V_{LED}$ = 5.5V | | 0.6 | 0.9 | W |
| | | $V_{LED}$ = 4.2V | | 0.3 | 0.6 | |
| Luminous Intensity per LED (Digit Avg.) | $I_\nu$[2] | $V_{LED}$ = 5.5V | 60 | 115 | | μcd |
| | | $V_{LED}$ = 4.2V | 40 | 80 | | |
| | | $V_{LED}$ = 3.5V | | 50 | | |
| Peak Wavelength | $\lambda_{peak}$ | | | 655 | | nm |
| Spectral Halfwidth | $\Delta\lambda_{1/2}$ | | | 30 | | nm |
| Weight | | | | 4.9 | | gram |

**Notes:**
1. All typical values at $T_C$ = 25°C
2. At $T_C$ = 25°C

# Absolute Maximum Ratings

| Description | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage Temperature, Ambient | $T_S$ | –65 | +100 | °C |
| Operating Temperature, Case | $T_C$ | –55 | +95 | °C |
| Plus, Plus/Minus Input Potential to Ground | $V_{LED}$ | –0.5 | 5.5 | V |

# Recommended Operating Conditions

| Description | Symbol | Min. | Nom. | Max. | Unit |
|---|---|---|---|---|---|
| LED Supply Voltage, Display Off | $V_{LED}$ | –0.5 | 0 | 1.0 | V |
| LED Supply Voltage, Display On | $V_{LED}$ | 3.0 | 4.2 | 5.5 | V |

## Applications

**Decimal Point Limiting Resistor**

The decimal point of the 5082-7010 display requires an external current limiting resistor, between pin 2 and ground. Recommended resistor value is 220Ω, 1/4 watt.

**Mounting**

The 5082-7010 and 5082-7011 displays are packaged with two rows of 4 contact pins each in a DIP configuration with a row center line spacing of 0.890 inches.

Normal mounting is directly onto a printed circuit board. If desired, these displays may be socket mounted using contact strip connectors such as Augat's 325-AGI or AMP 583773-1 or 583774-1.

**Heat Sink Operation**

Optimum display case operating temperature for the 5082-7010 and 7011 displays is $T_C$=0°C to 70°C as measured on back surface. Maintaining the display case operating temperature within this range may be achieved by mounting the display on an appropriate heat sink or metal core printed circuit board. Thermal conducting compound such as Wakefield 120 or Dow Corning 340 can be used between display and heat sink. See figure 10 for $V_{LED}$ derating vs. display case temperature.

**Operation Without Heat Sink**

These displays may also be operated without the use of a heat sink. The thermal resistance from case to ambient for these displays when soldered into a printed circuit board is nominally $\theta_{CA}$=30°C/W. See figure 12 for $V_{LED}$ derating vs. ambient temperature.

**Cleaning**

Post solder cleaning may be accomplished using water, Freon/alcohol mixtures formulated for vapor cleaning processing (up to 2 minutes in vapors at boiling) or Freon/alcohol mixtures formulated for room temperature cleaning. Suggested solvents: Freon TF, Freon TE, Genesolv DI-15, Genesolv DE-15.

HEWLETT PACKARD

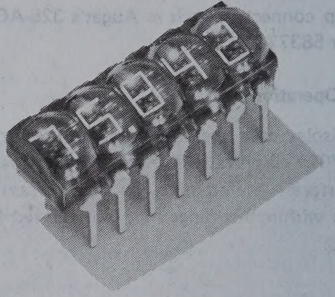
# LEADFRAME MOUNTED SEVEN SEGMENT MONOLITHIC NUMERIC INDICATORS

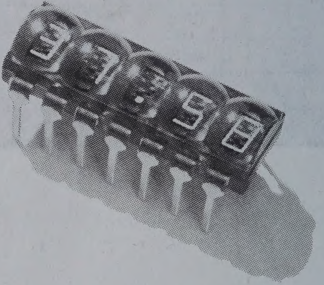
## 5082-7400/7430 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **COMPACT PACKAGE SIZES**
  **.25" Package Width**
  **.150" and .200" Digit Spacing**
- **STROBED OPERATION**
  **Minimizes Lead Connections**
- **FULLY ENCAPSULATED STANDARD DIP PACKAGES**
  **End Stackable**
  **Integral Red Filter**
  **Extremely Rugged Construction**
- **I.C. COMPATIBLE**
- **CATEGORIZED FOR LUMINOUS INTENSITY**
  **Assures uniformity of light output from unit to unit within single category.**



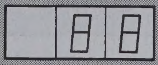
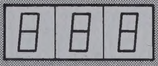
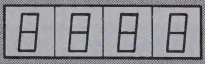
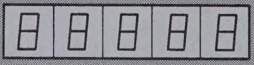


## Description

The HP 5082-7400/-7430 series are 2.79 mm (.11"), seven segment GaAsP numeric indicators packaged in 2, 3, 4 and 5 digit clusters. An integral magnification technique increases the luminous intensity, thereby making low power consumption possible. Options include either the standard lower right hand decimal point or a centered decimal point.

Applications include hand held calculators, portable instruments and many other products requiring compact, rugged, long lifetime active indicators.

## Device Selection Guide

| Digits per Cluster | Configuration | Inter-Digit Spacing mm (inches) | Part Number | |
|---|---|---|---|---|
| | Device | | Center Decimal Point | Right Decimal Point |
| 2 (right) |  | 5.08 (.200) | | 5082-7432 |
| 3 |  | 5.08 (.200) | | 5082-7433 |
| 4 |  | 3.81 (.150) | 5082-7404 | 5082-7414 |
| 5 |  | 3.81 (.150) | 5082-7405 | 5082-7415 |

## Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Peak Forward Current per Segment or dp (Duration < 500 μs)<br>5082-7432/7433 | $I_{PEAK}$ |  | 50 | mA |
| Peak Forward Current per Segment or dp (Duration < 1 msec)<br>5082-7404/7405/7414/7415 | $I_{PEAK}$ |  | 110 | mA |
| Average Current per Segment or dp | $I_{AVG}$ |  | 5 | mA |
| Power Dissipation per Digit[1] | $P_D$ |  | 80 | mW |
| Operating Temperature, Ambient | $T_A$ | −40 | 75 | °C |
| Storage Temperature | $T_S$ | −40 | 100 | °C |
| Reverse Voltage | $V_R$ |  | 5 | V |
| Solder Temperature 1/16" below seating plane (t ≤ 3 sec)[2] |  |  | 230 | °C |

Notes: 1. Derate linearly @ 1 mW/°C above 25°C ambient.
2. See Mechanical section for recommended flux removal solvents.

## Electrical/Optical Characteristics at $T_A = 25°C$

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment or dp[3,4]<br>5082-7432/7433 | $I_V$ | $I_{AVG} = 500\ \mu A$<br>($I_{PK} = 5$ mA<br>duty cycle = 10%) | 10 | 40 |  | μcd |
| Luminous Intensity/Segment or dp[3,4]<br>(Time Averaged)<br>5082-7404/7405/7414/7415 | $I_V$ | $I_{AVG} = 1$ mA<br>$I_{PK} = 10$ mA<br>duty cycle = 10%) | 5 | 20 |  | μcd |
| Peak Wavelength | $\lambda_{PEAK}$ |  |  | 655 |  | nm |
| Forward Voltage/Segment or dp<br>5082-7432/-7433 | $V_F$ | $I_F = 5$ mA |  | 1.55 | 2.0 | V |
| Forward Voltage/Segment or dp<br>5082-7404/7405/7414/7415 | $V_F$ | $I_F = 10$ mA |  | 1.55 | 2.0 | V |
| Reverse Voltage/Segment or dp | $V_R$ | $I_R = 200\ \mu A$ | 5 |  |  | V |
| Rise and Fall Time[5] | $t_r, t_f$ |  |  | 10 |  | ns |

Notes: 3. The digits are categorized for luminous intensity. Intensity categories are designated by a letter located on the back side of the package.
4. Operation at Peak Currents less than 5.0 mA is not recommended.
5. Time for a 10%-90% change of light intensity for step change in current.

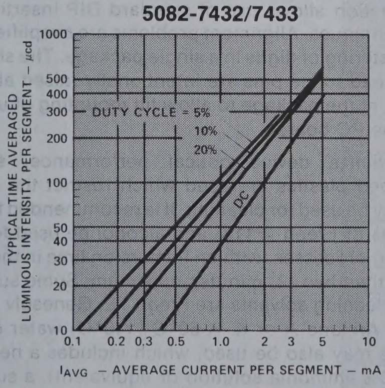


**Figure 1. Typical Time Averaged Luminous Intensity per Segment (Digit Average) vs. Current per Segment.**

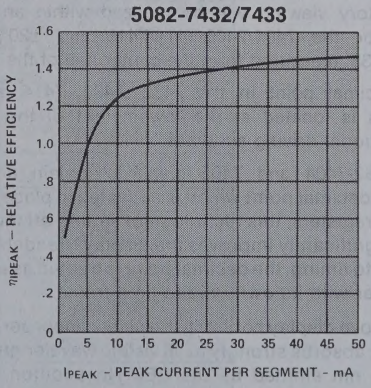


**Figure 2. Relative Luminous Efficiency vs. Peak Current per Segment.**

5082-7404/7405/7414/7415

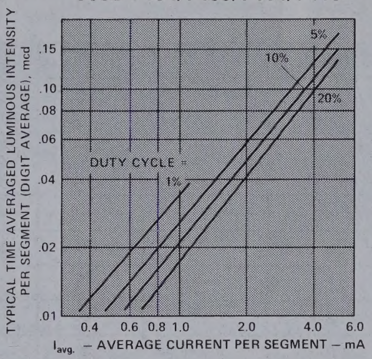


**Figure 3. Typical Time Averaged Luminous Intensity per Segment (Digit Average) vs. Average Current per Segment.**

5082-7404/7405/7414/7415

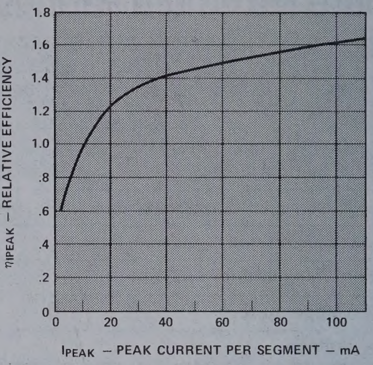


**Figure 4. Relative Luminous Efficiency vs. Peak Current per Segment.**

5082-7400/7430 SERIES

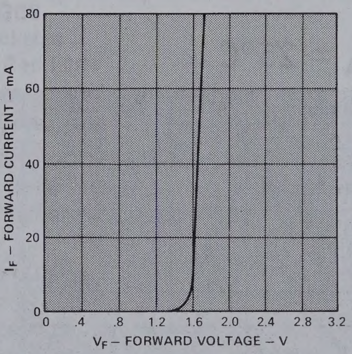


**Figure 5. Forward Current vs. Forward Voltage.**

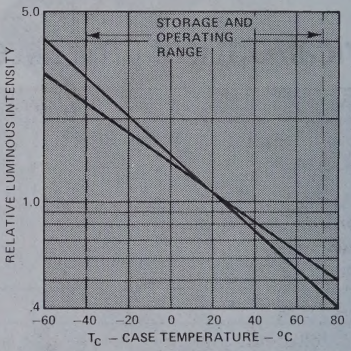


**Figure 6. Relative Luminous Intensity vs. Case Temperature at Fixed Current Level.**

# Electrical/Optical

The 5082-7400/7430 series devices utilize a monolithic GaAsP chip of 8 common cathode segments for each display digit. The segment anodes of each digit are interconnected, forming an 8 by N line array, where N is the number of characters in the display. Each chip is positioned under an integrally molded lens giving a magnified character height of 2.79mm (0.11) inches. Satisfactory viewing will be realized within an angle of ±30° for the 7404/7405/7414/7415 and ±20° for the 7432/7433, measured from the center line of the digit.

The decimal point in the 7432, 7433, 7414, and 7415 displays is located at the lower right of the digit for conventional driving schemes.

The 5082-7404 and 7405 displays contain a centrally located decimal point which is activated in place of a digit. In long registers, this technique of setting off the decimal point significantly improves the display's readability. With respect to timing, the decimal point is treated as a separate character with its own unique time frame.

To improve display contrast, the plastic incorporates a red dye that absorbs strongly at all visible wavelengths except the 655 nm emitted by the LED. In addition, the lead frames are selectively darkened to reduce reflectance. An additional filter, such as Plexiglass 2423, Panelgraphic 60 or 63, and SGL Homalite 100-1605, will further lower the ambient reflectance and improve display contrast.

# Mechanical

The 5082-7400/7430 series package is a standard 12 or 14 Pin DIP consisting of a plastic encapsulated lead frame with integral molded lenses. It is designed for plugging into DIP sockets or soldering into PC boards. The lead frame construction allows use of standard DIP insertion tools and techniques. Alignment problems are simplified due to the clustering of digits in a single package. The shoulders of the lead frame pins are intentionally raised above the bottom of the package to allow tilt mounting of up to 20° from the PC board.

To optimize device optical performance, specially developed plastics are used which restrict the solvents that may be used for cleaning. It is recommended that only mixtures of Freon (F113) and alcohol be used for vapor cleaning processes, with an immersion time in the vapors of less than two (2) minutes maximum. Some suggested vapor cleaning solvents are Freon TE, Genesolv DI-15 or DE-15, Arklone A or K. A 60°C (140°C) water cleaning process may also be used, which includes a neutralizer rinse (3% ammonia solution or equivalent), a surfactant rinse (1% detergent solution or equivalent), a hot water rinse and a thorough air dry. Room temperature cleaning may be accomplished with Freon T-E35 or T-P35, Ethanol, Isopropanol or water with a mild detergent.

# Package Description 5082-7404, -7405, -7414, -7415

Notes: 6. Dimensions in millimeters and (inches).
7. Tolerances on all dimensions are ±0.038 mm (±.015 in.) unless otherwise noted.

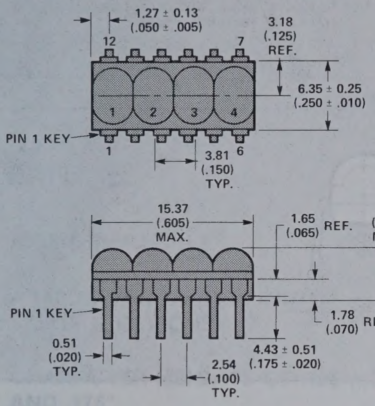

1.27 ± 0.13
(.050 ± .005)
12
7
3.18
(.125)
REF.
6.35 ± 0.25
(.250 ± .010)
1
2
3
4
PIN 1 KEY
1
6
3.81
(.150)
TYP.
15.37
(.605)
MAX.
1.65
(.065)
REF.
4.83
(.190)
MAX.
PIN 1 KEY
1.78
(.070)
REF.
0.51
(.020)
TYP.
4.43 ± 0.51
(.175 ± .020)
2.54
(.100)
TYP.

Figure 7. 5082-7404/7414

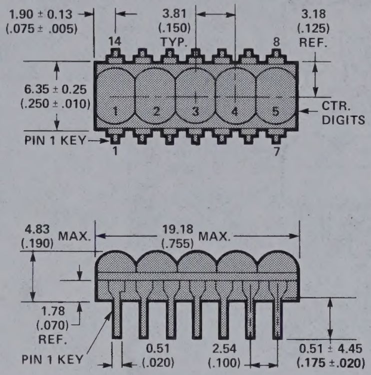

1.90 ± 0.13
(.075 ± .005)
3.81
(.150)
TYP.
3.18
(.125)
REF.
14
8
6.35 ± 0.25
(.250 ± .010)
1
2
3
4
5
CTR.
DIGITS
PIN 1 KEY
1
7
4.83
(.190)
MAX.
19.18
(.755)
MAX.
1.78
(.070)
REF.
PIN 1 KEY
0.51
(.020)
2.54
(.100)
0.51 ± 4.45
(.175 ± .020)

Figure 8. 5082-7405/7415.

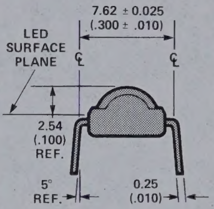

7.62 ± 0.025
(.300 ± .010)
LED
SURFACE
PLANE
℄
℄
2.54
(.100)
REF.
5°
REF.
0.25
(.010)

Figure 9. 5082-7404/7405/7414/7415

# Magnified Character Font Description

DIMENSIONS IN MILLIMETERS AND (INCHES).

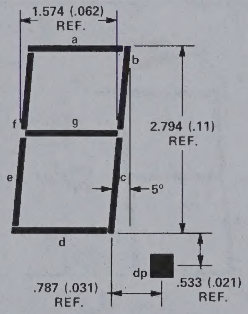

1.574 (.062)
REF.
a
b
f
g
2.794 (.11)
REF.
e
c
5°
d
dp
.787 (.031)
REF.
.533 (.021)
REF.

Figure 10. Center and Right Decimal Point Configuration.

**DEVICES**

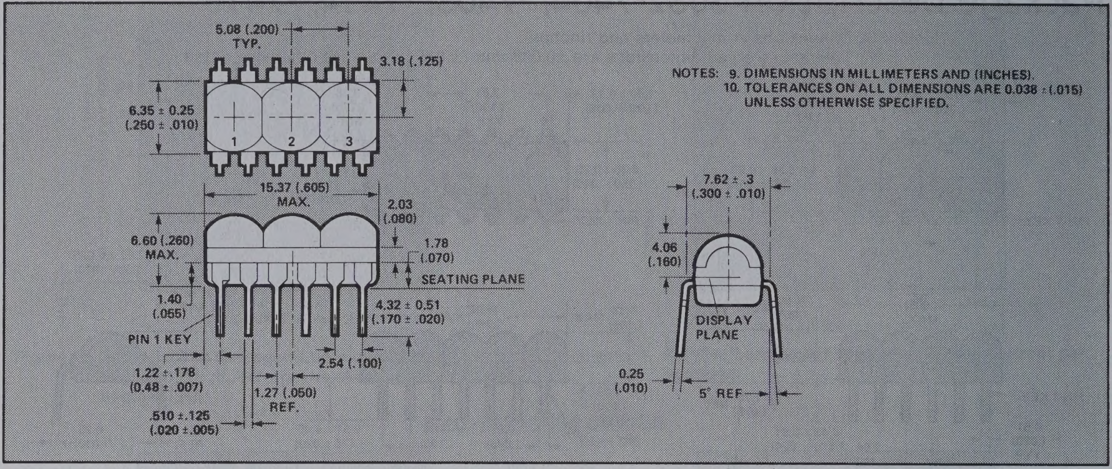
5082-7404
5082-7405
5082-7414
5082-7415

# Device Pin Description

| 5082-7404/7414 FUNCTION | 5082-7405/7415 FUNCTION |
|---|---|
| CATHODE 1 | CATHODE 1 |
| ANODE e | ANODE e |
| ANODE c | ANODE c |
| CATHODE 3 | CATHODE 3 |
| ANODE dp | ANODE dp |
| CATHODE 4 | ANODE d |
| ANODE g | CATHODE 5 |
| ANODE d | ANODE g |
| ANODE f | CATHODE 4 |
| CATHODE 2 | ANODE f |
| ANODE b | SEE NOTE 8. |
| ANODE a | ANODE b |
| — | CATHODE 2 |
| — | ANODE a |

Note 8: Leave Pin Unconnected.

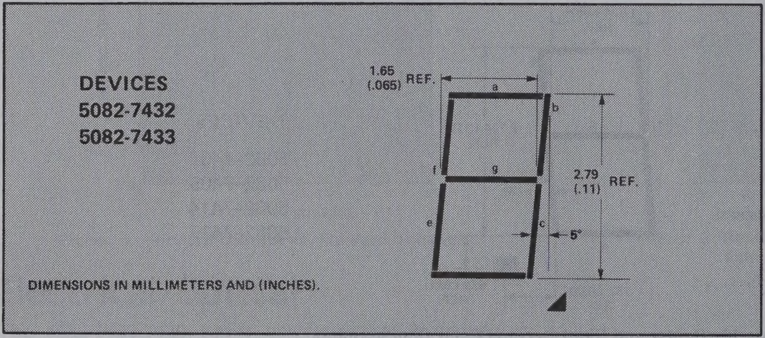
# Package Description 5082-7432, -7433


5.08 (.200) TYP.
3.18 (.125)
6.35 ± 0.25 (.250 ± .010)
1
2
3
15.37 (.605) MAX.
2.03 (.080)
6.60 (.260) MAX.
1.78 (.070)
SEATING PLANE
1.40 (.055)
4.32 ± 0.51 (.170 ± .020)
PIN 1 KEY
2.54 (.100)
1.22 ±.178 (0.48 ± .007)
1.27 (.050) REF.
.510 ±.125 (.020 ±.005)
7.62 ± .3 (.300 ± .010)
4.06 (.160)
DISPLAY PLANE
0.25 (.010)
5° REF

NOTES: 9. DIMENSIONS IN MILLIMETERS AND (INCHES).
10. TOLERANCES ON ALL DIMENSIONS ARE 0.038 ±(.015) UNLESS OTHERWISE SPECIFIED.

Figure 11.

# Magnified Character Font Description


1.65 (.065) REF.
a
b
f
g
2.79 (.11) REF.
e
c
5°

**DEVICES**
**5082-7432**
**5082-7433**

DIMENSIONS IN MILLIMETERS AND (INCHES).

Figure 12.

# Device Pin Description

| PIN NUMBER | 5082-7432 FUNCTION | 5082-7433 FUNCTION |
|---|---|---|
| 1 | SEE NOTE 11. | CATHODE 1 |
| 2 | ANODE e | ANODE e |
| 3 | ANODE d | ANODE d |
| 4 | CATHODE 2 | CATHODE 2 |
| 5 | ANODE c | ANODE c |
| 6 | ANODE dp | ANODE dp |
| 7 | CATHODE 3 | CATHODE 3 |
| 8 | ANODE b | ANODE b |
| 9 | ANODE g | ANODE g |
| 10 | ANODE a | ANODE a |
| 11 | ANODE f | ANODE f |
| 12 | SEE NOTE 11. | SEE NOTE 11. |

NOTE 11. Leave Pin unconnected.

HEWLETT PACKARD

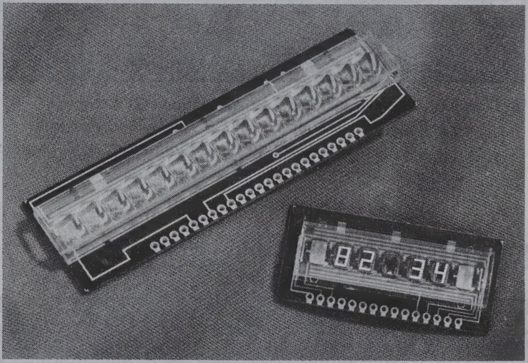
# PRINTED CIRCUIT BOARD MOUNTED SEVEN SEGMENT NUMERIC INDICATORS

## 5082-7200/7440 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **MOS COMPATIBLE**
- **AVAILABLE IN 9 TO 16 DIGIT CONFIGURATIONS**
- **CHARACTER HEIGHTS OF .105", .115" AND .175"**
- **LOW POWER**
- **CATEGORIZED FOR LUMINOUS INTENSITY**



## Description

The HP-5082-7200/7440 series of displays are seven segment GaAsP Numeric Indicators mounted on printed circuit boards. A plastic lens magnifies the digits and includes an integral protective bezel. Character heights of .105" (2.67 mm), .115" (2.92 mm) and .175" (4.45 mm) are available. For large quantity applications, digit string lengths of 8, 12 and 14 digits are available by special order.

Applications are hand held calculators and portable equipment requiring compact, low power, long life time, active displays.

## Device Selection Guide

| Part Number | Digits Per PC Board | Decimal Point | Package | Character Height (mm) in. | Inter-Digit Spacing (mm) in. |
|---|---|---|---|---|---|
| 5082-7441 | 9 | Right Hand | Fig. 9 | (2.67) .105" | (5.08) .200" |
| 5082-7446 | 16 | Right Hand | Fig. 11 | (2.92) .115" | (3.81) .150" |
| 5082-7285 | 5 | Right Hand | Fig. 14 | (4.45) .175" | (5.84) .230" |
| 5082-7295 | 15 | Right Hand | Fig. 13 | (4.45) .175" | (5.84) .230" |

## Maximum Ratings 5082-7441/7446

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Peak Forward Current per Segment or dp (Duration < 500µs) | $I_{PEAK}$ | | 50 | mA |
| Average Current per Segment or dp[1] | $I_{AVG}$ | | 3 | mA |
| Power Dissipation per Digit [2] | $P_D$ | | 50 | mW |
| Operating Temperature, Ambient | $T_A$ | -20 | +85 | °C |
| Storage Temperature | $T_S$ | -20 | +85 | °C |
| Reverse Voltage | $V_R$ | | 3 | V |
| Solder Temperature at connector edge ($t \leqslant 3$ sec.)[3] | | | 230 | °C |

NOTES:
1. Derate linearly at 0.1mA/°C above 60°C ambient.
2. Derate linearly at 1.7mW/°C above 60°C ambient.
3. See Mechanical section for recommended soldering techniques and flux removal solvents.

## Maximum Ratings 5082-7285/7295

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Peak Forward Current per Segment or DP (Duration <35µs) | $I_{PEAK}$ | | 200 | mA |
| Average Current per Segment or DP (4) | $I_{AVG}$ | | 7 | mA |
| Power Dissipation per Digit (5) | $P_D$ | | 125 | mW |
| Operating Temperature, Ambient | $T_A$ | -20 | +70 | °C |
| Storage Temperature | $T_S$ | -20 | +80 | °C |
| Reverse Voltage | $V_R$ | | 3 | V |
| Solder Temperature at connector edge ($t \leqslant 3$ sec.) (6) | | | 230 | °C |

NOTES:
4. Derate linearly at 0.12mA/°C above 25°C ambient.
5. Derate linearly at 2.3mW/°C above 25°C ambient.
6. See Mechanical section for recommended soldering techniques and flux removal solvents.

## Electrical/Optical Characteristics at $T_A$ = 25°C 5082-7441/7446

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment or dp[7]<br>5082-7440 | $I_V$ | $I_{AVG}$ = 500µA<br>($I_{PK}$ = 5mA<br>duty cycle = 10%) | 9 | 40 | | µcd |
| 5082-7446 | | 5mA Peak<br>1/16 Duty Cycle | 7 | 35 | | µcd |
| Peak Wavelength | $\lambda_{peak}$ | | | 655 | | nm |
| Forward Voltage/Segment or dp | $V_F$ | $I_F$ = 5mA | | 1.55 | | V |

NOTES: 7. Operation at Peak Currents of less than 3.5mA is not recommended.

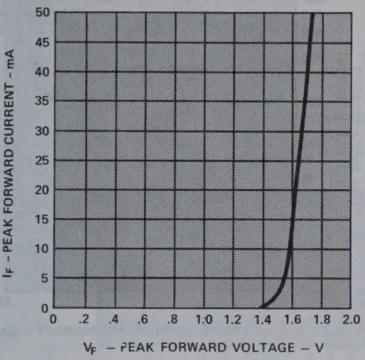


**Figure 1. Peak Forward Current vs. Peak Forward Voltage.**

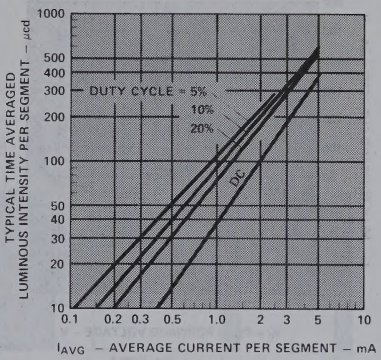


**Figure 2. Typical Time Averaged Luminous Intensity per Segment vs. Average Current per Segment.**

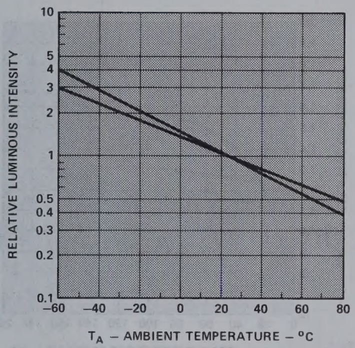


**Figure 3. Relative Luminous Intensity vs. Ambient Temperature at Fixed Current Level.**

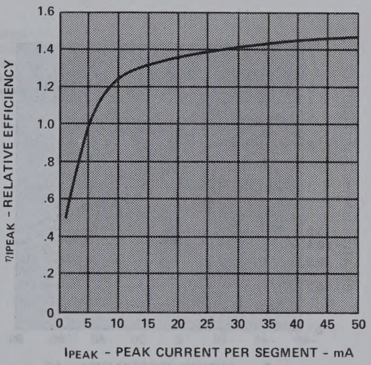


**Figure 4. Relative Luminous Efficiency vs. Peak Current per Segment.**

## Electrical/Optical Characteristics at $T_A = 25°C$ 5082-7285/7295

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Luminous Intensity/Segment or dp (Time Averaged) 15 digit display 5082-7295[8,10] | $I_v$ | $I_{avg.} = 2$ mA (30 mA Peak 1/15 duty cycle) | 30 | 90 | | μcd |
| Luminous Intensity/Segment or dp (Time Averaged) 5 digit display 5082-7285[8,10] | $I_v$ | $I_{avg.} = 2$ mA (10 mA Peak 1/5 duty cycle) | 30 | 70 | | μcd |
| Forward Voltage per Segment or dp 5082-7295 15 digit display | $V_F$ | $I_F = 30$ mA | | 1.60 | 2.3 | V |
| Forward Voltage per Segment or dp 5082-7285 5 digit display | $V_F$ | $I_F = 10$ mA | | 1.55 | 2.0 | V |
| Peak Wavelength | $\lambda_{PEAK}$ | | | 655 | | nm |
| Dominant Wavelength[9] | $\lambda_d$ | | | 640 | | nm |
| Reverse Current per Segment or dp | $I_R$ | $V_R = 5V$ | | 10 | | μA |
| Temperature Coefficient of Forward Voltage | $\Delta V_F/°C$ | | | -2.0 | | mV/°C |

NOTES:

8. The luminous intensity at a specific ambient temperature, $I_V(T_A)$, may be calculated from this relationship: $I_V(T_A) = I_{V(25°C)}(.985)^{(T_A - 25°C)}$
9. The dominant wavelength $\lambda_d$, is derived from the C.I.E. Chromaticity Diagram and represents the single wavelength which defines the color of the device.
10. Operation at peak currents of less than 6.0 mA is not recommended.

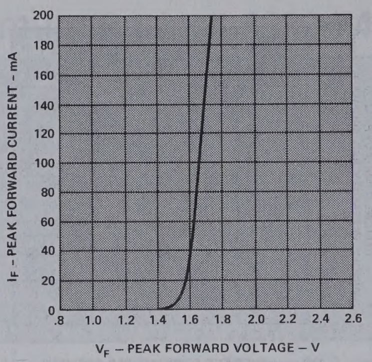


**Figure 5. Peak Forward Current vs. Peak Forward Voltage.**

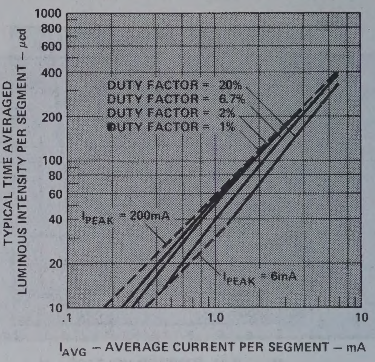


**Figure 6. Typical Time Averaged Luminous Intensity per Segment vs. Average Current per Segment.**

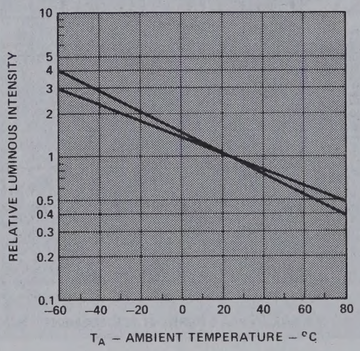


**Figure 7. Relative Luminous Intensity vs. Ambient Temperature at Fixed Current Level.**

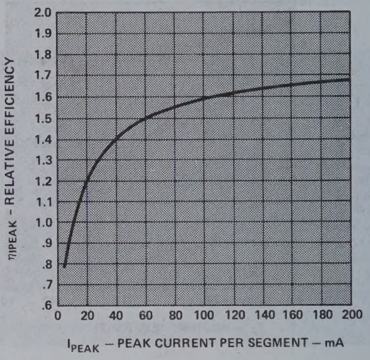


**Figure 8. Relative Luminous Efficiency vs. Peak Current per Segment.**

# Mechanical

These devices are constructed on a standard printed circuit board substrate. A separately molded plastic lens is attached to the PC board over the digits. The lens is an acrylic styrene material that gives good optical lens performance, but is subject to scratching so care should be exercised in handling.

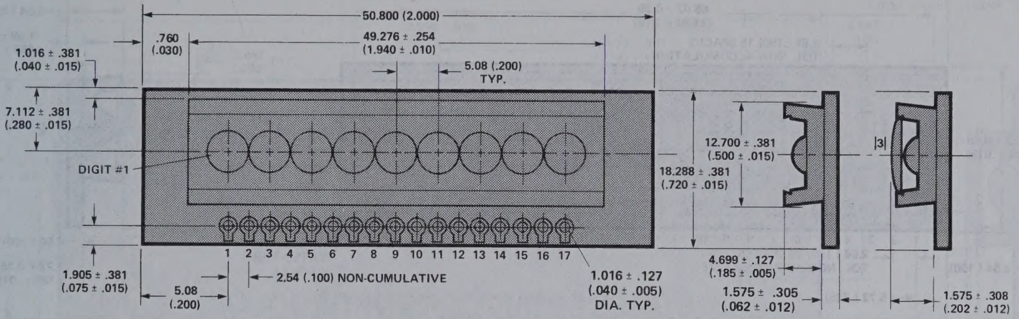
The device may be mounted either by use of pins which may be hand soldered into the plated through holes at the connector edge of the PC board or by insertion into a standard PC board connector. The devices may be hand soldered for up to 3 seconds per tab at a maximum soldering temperature of 230°C. Heat should be applied only to the edge connector tab areas of the PC board. Heating other areas of the board to temperatures in excess of 85°C can result in permanent damage to the display. It is recommended that a rosin core wire solder or a low temperature deactivating flux and solid wire solder be used in soldering operations.

The PC board is silver plated. To prevent the formation of a tarnish ($Ag_2S$) which could impair solderability the displays should be stored in the unopened shipping packages until they are used. Further information on the storage, handling, and cleaning of silver plated components is contained in Hewlett-Packard Application Bulletin No. 3.

# Electrical/Optical

The HP 5082-7441, -7446, -7285 and 7295 devices utilize a monolithic GaAsP chip containing 7 segments and a decimal point for each display digit. The segments of each digit are interconnected, forming an 8 by N line array, where N is the number of digits in the display. Each chip is positioned under a separate element of a plastic magnifying lens, producing a magnified character. Satisfactory viewing will be realized within an angle of approximately ±20° from the centerline of the digit. A filter, such as plexiglass 2423, Panelgraphic 60 or 63, and Homalite 100-1600, will lower the ambient reflectance and improve display contrast. Digit encoding of these devices is performed by standard 7 segment decoder driver circuits.

# Package Dimensions

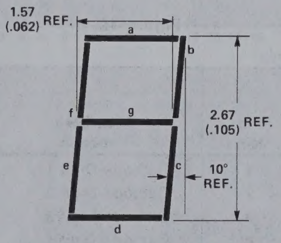

50.800 (2.000)
.760 (.030)
49.276 ± .254 (1.940 ± .010)
1.016 ± .381 (.040 ± .015)
5.08 (.200) TYP.
7.112 ± .381 (.280 ± .015)
DIGIT #1
12.700 ± .381 (.500 ± .015)
18.288 ± .381 (.720 ± .015)
|3|
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
1.905 ± .381 (.075 ± .015)
2.54 (.100) NON-CUMULATIVE
5.08 (.200)
1.016 ± .127 (.040 ± .005) DIA. TYP.
4.699 ± .127 (.185 ± .005)
1.575 ± .305 (.062 ± .012)
1.575 ± .308 (.202 ± .012)

NOTES:
1. Dimensions in millimeters and (inches).
2. Logo and part number are on back of package.
3. Secondary 1.25X magnifier that slides into primary lens and increases character height to 3.33 (.131) available as special product.
4. Tolerances: ±.881 (.015)

**Figure 9. 5082-7441**

# Magnified Character Font Description

**5082-7441**


1.57 (.062) REF.
a
b
f
g
2.67 (.105) REF.
e
c
10° REF.
d

Note: All dimensions in millimeters and (inches).

**Figure 10.**

# Device Pin Description

| Pin No. | 5082-7441 Function | Pin No. | 5082-7441 Function |
|---|---|---|---|
| 1 | Dig. 1 Cathode | 10 | Seg. d Anode |
| 2 | Seg. c Anode | 11 | Dig. 6 Cathode |
| 3 | Dig. 2 Cathode | 12 | Seg. g Anode |
| 4 | d.p. Anode | 13 | Dig. 7 Cathode |
| 5 | Dig. 3 Cathode | 14 | Seg. b Anode |
| 6 | Seg. a Anode | 15 | Dig. 8 Cathode |
| 7 | Dig. 4 Cathode | 16 | Seg. f Anode |
| 8 | Seg. e Anode | 17 | Dig. 9 Cathode |
| 9 | Dig. 5 Cathode | | |

# Package Dimensions

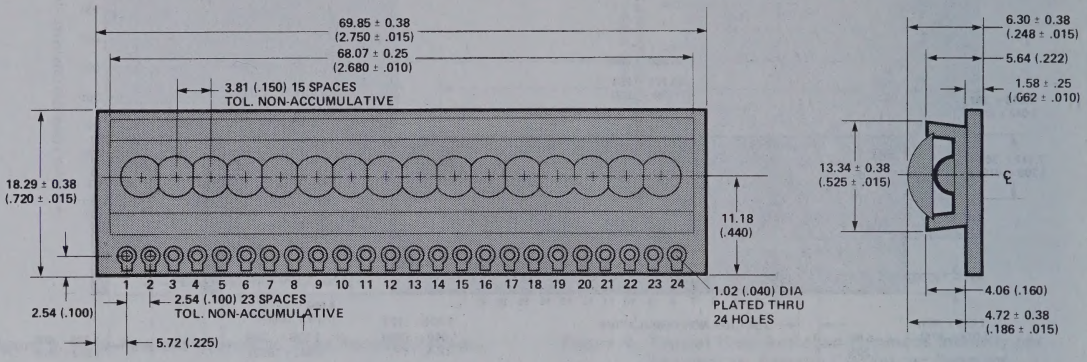
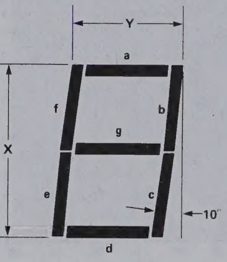

69.85 ± 0.38
(2.750 ± .015)
68.07 ± 0.25
(2.680 ± .010)
3.81 (.150) 15 SPACES
TOL. NON-ACCUMULATIVE
18.29 ± 0.38
(.720 ± .015)
11.18
(.440)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
2.54 (.100) 23 SPACES
TOL. NON-ACCUMULATIVE
2.54 (.100)
5.72 (.225)
1.02 (.040) DIA
PLATED THRU
24 HOLES
6.30 ± 0.38
(.248 ± .015)
5.64 (.222)
1.58 ± .25
(.062 ± .010)
13.34 ± 0.38
(.525 ± .015)
℄
4.06 (.160)
4.72 ± 0.38
(.186 ± .015)

Figure 11. 5082-7446

# Magnified Character Font Description


Y
a
f
b
g
X
e
c
10°
d

| DEVICE | X | Y |
|---|---|---|
| 5082-7446 | 2.92<br>(.115) | 1.40<br>(.055) |

NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES).
2. TOLERANCES ON ALL DIMENSIONS ARE ±0.38 (.015) UNLESS OTHERWISE SPECIFIED.

Figure 12.

# Device Pin Description

| Pin No. | 5082-7446 Function |
|---|---|
| 1 | Cathode-Digit 1 |
| 2 | Cathode-Digit 2 |
| 3 | Cathode-Digit 3 |
| 4 | Cathode-Digit 4 |
| 5 | Cathode-Digit 5 |
| 6 | Anode-Segment e |
| 7 | Cathode-Digit 6 |
| 8 | Anode-Segment d |
| 9 | Cathode-Digit 7 |
| 10 | Anode-Segment a |
| 11 | Cathode-Digit 8 |
| 12 | Anode-Segment DP |
| 13 | Cathode-Digit 9 |
| 14 | Anode-Segment c |
| 15 | Cathode-Digit 10 |
| 16 | Anode-Segment g |
| 17 | Cathode-Digit 11 |
| 18 | Anode-Segment b |
| 19 | Cathode-Digit 12 |
| 20 | Anode-Segment f |
| 21 | Cathode-Digit 13 |
| 22 | Cathode-Digit 14 |
| 23 | Cathode-Digit 15 |
| 24 | Cathode-Digit 16 |

# Package Dimensions

ALL DIMENSIONS IN MILLIMETERS AND (INCHES).

TOLERANCES ARE ±0.203 (±.008) UNLESS OTHERWISE NOTED

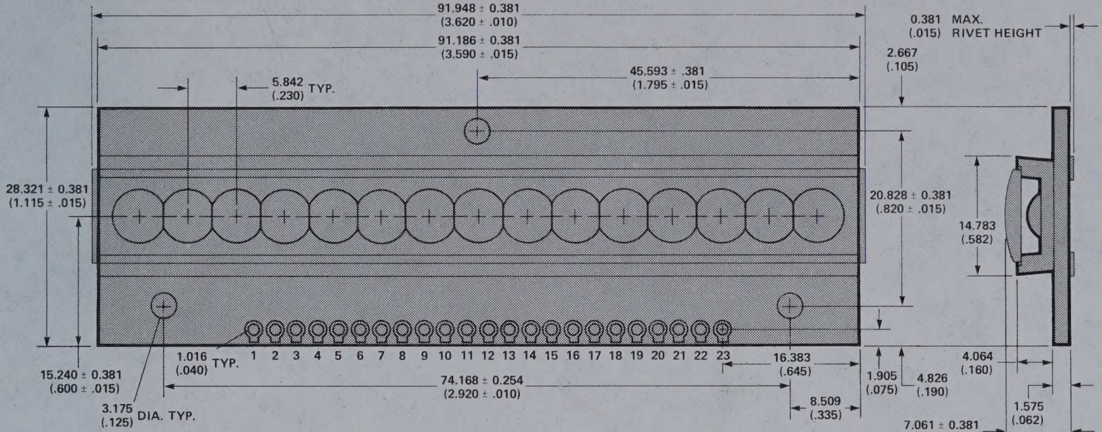

91.948 ± 0.381
(3.620 ± .010)
91.186 ± 0.381
(3.590 ± .015)
0.381 (.015) MAX. RIVET HEIGHT
2.667
(.105)
45.593 ± .381
(1.795 ± .015)
5.842 (.230) TYP.
28.321 ± 0.381
(1.115 ± .015)
20.828 ± 0.381
(.820 ± .015)
14.783
(.582)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1.016 (.040) TYP.
16.383
(.645)
4.064
(.160)
15.240 ± 0.381
(.600 ± .015)
74.168 ± 0.254
(2.920 ± .010)
1.905
(.075)
4.826
(.190)
3.175 (.125) DIA. TYP.
8.509
(.335)
1.575
(.062)
7.061 ± 0.381
(.278 ± .015)

**Figure 13. 5082-7295**

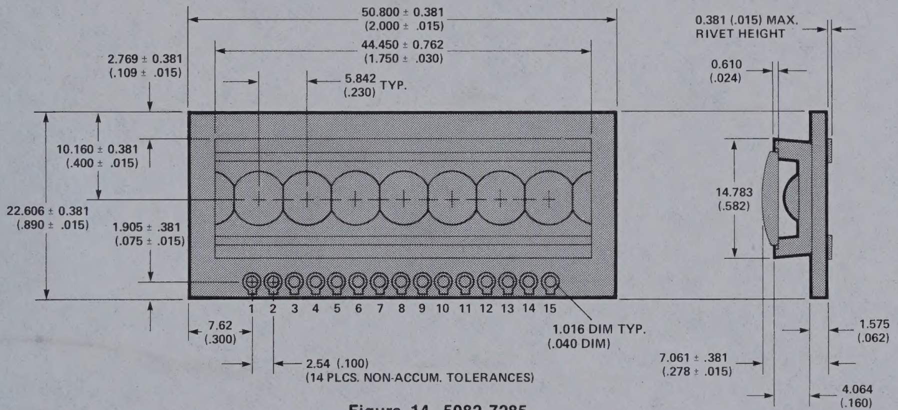
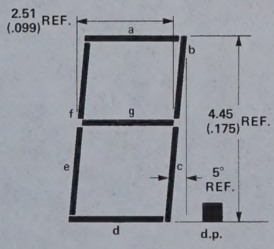

50.800 ± 0.381
(2.000 ± .015)
44.450 ± 0.762
(1.750 ± .030)
0.381 (.015) MAX. RIVET HEIGHT
2.769 ± 0.381
(.109 ± .015)
5.842 (.230) TYP.
0.610
(.024)
10.160 ± 0.381
(.400 ± .015)
22.606 ± 0.381
(.890 ± .015)
1.905 ± .381
(.075 ± .015)
14.783
(.582)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
7.62
(.300)
1.016 DIM TYP.
(.040 DIM)
1.575
(.062)
2.54 (.100)
(14 PLCS. NON-ACCUM. TOLERANCES)
7.061 ± .381
(.278 ± .015)
4.064
(.160)

**Figure 14. 5082-7285**

# Magnified Character Font Description

**DEVICES**

5082-7285
5082-7295


2.51 (.099) REF.
a
b
f
g
4.45 (.175) REF.
e
c
5° REF.
d
d.p.

ALL DIMENSIONS IN MILLIMETERS AND (INCHES).

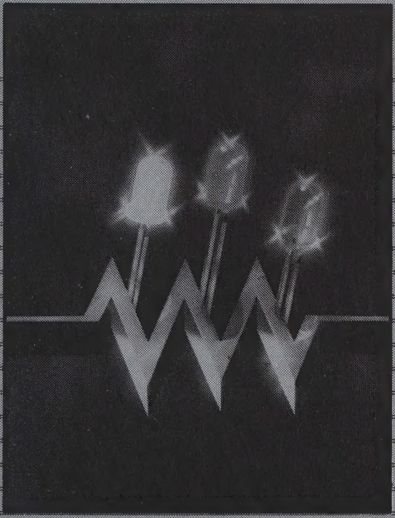
**Figure 15.**

# Device Pin Description

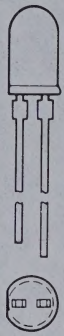
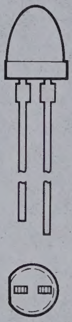
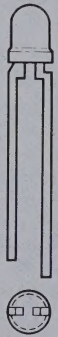
| Pin No. | 5082-7285 Function | 5082-7295 Function |
|---|---|---|
| 1 | Anode Segment b | Cathode Digit 1 |
| 2 | Anode Segment g | Cathode Digit 2 |
| 3 | Anode Segment e | Cathode Digit 3 |
| 4 | Cathode Digit 1 | Cathode Digit 4 |
| 5 | Cathode Digit 2 | Anode Segment dp |
| 6 | Cathode Digit 3 | Cathode Digit 5 |
| 7 | Cathode Digit 4 | Anode Segment c |
| 8 | Cathode Digit 5 | Cathode Digit 6 |
| 9 | Cathode Digit 6 | Anode Segment e |
| 10 | Cathode Digit 7 | Cathode Digit 7 |
| 11 | Anode Segment dp | Anode Segment a |
| 12 | Anode Segment d | Cathode Digit 8 |
| 13 | Anode Segment c | Anode Segment g |
| 14 | Anode Segment a | Cathode Digit 9 |
| 15 | Anode Segment f | Anode Segment d |
| 16 | | Cathode Digit 10 |
| 17 | | Anode Segment f |
| 18 | | Cathode Digit 11 |
| 19 | | Anode Segment b |
| 20 | | Cathode Digit 12 |
| 21 | | Cathode Digit 13 |
| 22 | | Cathode Digit 14 |
| 23 | | Cathode Digit 15 |

# Solid State Lamps

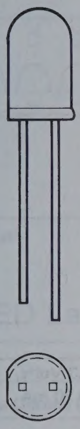
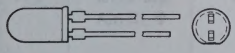
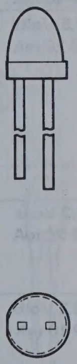
- *Selection Guide ............. 176*
- *New High Efficiency Red, Yellow, and Green Lamps*
- *T-1 3/4 and T-1 Lamps*
- *Rectangular and Subminiature Lamps*
- *Integrated Lamps*
- *Hermetically Sealed Lamps*
- *Panel Mounting Kit*



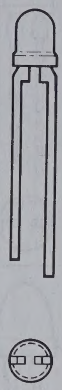
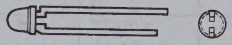
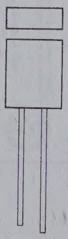
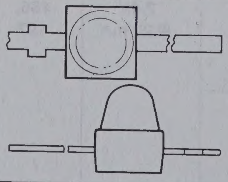
# Ultra Bright Lamps

| Device | | Description | | | Typical Luminous Intensity | $2\theta_{1/2}$[1] | Typical Forward Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color[2] | Package | Lens | | | | |
|  | HLMP-3750 | High Efficiency Red | T-1¾ | Red Untinted Non-Diffused | 125 mcd @ 20 mA | 24° | 2.2V @ 20 mA | 182 |
| | HLMP-3850 | Yellow | | Yellow Untinted Non-Diffused | 140 mcd @ 20 mA | | | |
| | HLMP-3950 | Green | | Green Untinted Non-Diffused | 120 mcd @ 20 mA | | 2.3V @ 20 mA | |
|  | HLMP-3390 | High Efficiency Red | T-1¾ Low Profile | Red Untinted Non-Diffused | 55 mcd @ 20 mA | 32° | 2.2V @ 20 mA | |
| | HLMP-3490 | Yellow | | Yellow Untinted Non-Diffused | | | | |
| | HLMP-3590 | Green | | Green Untinted Non-Diffused | | | 2.3V @ 20 mA | |
|  | HLMP-1340 | High Efficiency Red | T-1 | Red Untinted Non-Diffused | 35 mcd @ 20 mA | 45° | 2.2V @ 20 mA | |
| | HLMP-1440 | Yellow | | Yellow Untinted Non-Diffused | | | | |
| | HLMP-1540 | Green | | Green Untinted Non-Diffused | | | 2.3V @ 20 mA | |

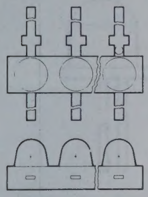
# High Efficiency Red, Yellow, High Performance Green LED Lamps

| Device | | Description | | | Typical Luminous Intensity | 2θ½[1] | Typical Forward Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
| **Package Outline Drawing** | **Part No.** | **Color[2]** | **Package** | **Lens** | | | | |
|  | HLMP-3300<br>(5082-4650) | High Efficiency Red (626 nm) | T-1¾[3] | Red Diffused | 3.5 mcd @ 10 mA | 90° | 2.2V @ 10 mA | 193 |
| | HLMP-3301<br>(5082-4655) | | | | 7.0 mcd @ 10 mA | | | |
| | HLMP-4600 | | | | 10.0 mcd @ 20 mA | 32° | | 190 |
| | HLMP-4601 | | | | 20.0 mcd @ 20 mA | | | |
| | HLMP-3315<br>(5082-4657) | | | Red Non-Diffused | 18.0 mcd @ 10 mA | 35° | | 193 |
| | HLMP-3316<br>(5082-4658) | | | | 30.0 mcd @ 10 mA | | | |
| | HLMP-3400<br>(5082-4550) | Yellow (585 nm) | | Yellow Diffused | 4.0 mcd @ 10 mA | 90° | | |
| | HLMP-3401<br>(5082-4555) | | | | 8.0 mcd @ 10 mA | | | |
| | HLMP-3415<br>(5082-4557) | | | Yellow Non-Diffused | 18.0 mcd @ 10 mA | 35° | | |
| | HLMP-3416<br>(5082-4558) | | | | 30.0 mcd @ 10 mA | | | |
| | HLMP-3502 | Green (569 nm) | | Green Diffused | 6.0 mcd @ 20 mA | 75° | 2.3V @ 20 mA | 186, 193 |
| | HLMP-3507 | | | | 12.0 mcd @ 20 mA | | | |
| | HLMP-3517 | | | Green Non-Diffused | 25.0 mcd @ 20 mA | 24° | | |
| | HLMP-3519 | | | | 50.0 mcd @ 20 mA | | | |
|  | HLMP-4610 [1] | High Efficiency Red (626 nm) | | Red Diffused | 10 mcd @ 20 mA | 32° | 2.2V @ 10 mA | 190 |
|  | HLMP-3350<br>(5082-4690) | High Efficiency Red (626 nm) | T-1¾ Low Profile | Red Diffused | 3.5 mcd @ 10 mA | 50° | 2.2V @ 10 mA | 197 |
| | HLMP-3351<br>(5082-4693) | | | | 7.0 mcd @ 10 mA | | | |
| | HLMP-3365<br>(5082-4694) | | | Red Non-Diffused | 10.0 mcd @ 10 mA | 45° | | |
| | HLMP-3366<br>(5082-4695) | | | | 18.0 mcd @ 10 mA | | | |
| | HLMP-3450<br>(5082-4590) | Yellow (585 nm) | | Yellow Diffused | 4.0 mcd @ 10 mA | 50° | | |
| | HLMP-3451<br>(5082-4592) | | | | 10.0 mcd @ 10 mA | | | |
| | HLMP-3465<br>(5082-4595) | | | Yellow Non-Diffused | 12.0 mcd @ 10 mA | 45° | | |
| | HLMP-3466<br>(5082-4597) | | | | 18.0 mcd @ 10 mA | | | |
| | HLMP-3553 | Green (572 nm) | | Green Diffused | 8.0 mcd @ 20 mA | 50° | 2.4V @ 20 mA | 186, 197 |
| | HLMP-3554 | | | | 15.0 mcd @ 20 mA | | | |
| | HLMP-3567 | | | Green Non-Diffused | 15.0 mcd @ 20 mA | 40° | | |
| | HLMP-3568 | | | | 35.0 mcd @ 20 mA | | | |

# High Efficiency Red, Yellow, High Performance Green LED Lamps (continued)

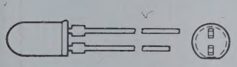
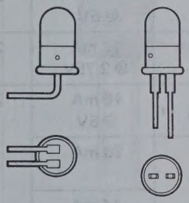
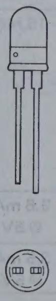
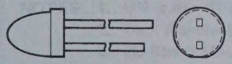
| Device | | Description | | | Typical Luminous Intensity | 2Θ½[1] | Typical Forward Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color[2] | Package | Lens | | | | |
|  | HLMP-1300 | High Efficiency Red (626 nm) | T-1[4] | Red Diffused | 2.0 mcd @ 10 mA | 60° | 2.2 Volts @ 10 mA | 207 |
| | HLMP-1301 | | | | 2.5 mcd @ 10 mA | | | |
| | HLMP-1302 | | | | 4.0 mcd @ 10 mA | | | |
| | HLMP-1320 | | | Untinted Non-Diffused | | 45° | | |
| | HLMP-1321 | | | Red Non-Diffused | | | | |
| | HLMP-1400 | Yellow (585 nm) | | Yellow Diffused | 2.0 mcd @ 10 mA | 60° | | |
| | HLMP-1401 | | | | 3.0 mcd @ 10 mA | | | |
| | HLMP-1402 | | | | 4.0 mcd @ 10 mA | | | |
| | HLMP-1420 | | | Untinted Non-Diffused | | 45° | | |
| | HLMP-1421 | | | Yellow Non-Diffused | | | | |
| | HLMP-1503 | Green (569 nm) | | Green Diffused | 5.0 mcd @ 20 mA | 60° | 2.3 Volts @ 20 mA | 186, 207 |
| | HLMP-1523 | | | | 10.0 mcd @ 20 mA | | | |
| | HLMP-1520 | | | Untinted Non-Diffused | 4.0 mcd @ 20 mA | 45° | | |
| | HLMP-1521 | | | Yellow Non-Diffused | | | | |
|  | HLMP-1350 | High Efficiency Red (626 nm) | T-1 Low Profile[4] | Red Diffused | 2.0 mcd @ 10 mA | 54° | 2.2 Volts @ 10 mA | 211 |
| | HLMP-1450 | Yellow (585 nm) | | Yellow Diffused | | | | |
| | HLMP-1550 | Green (569 nm) | | Green Diffused | 2.0 mcd @ 20 mA | | 2.3 Volts @ 20 mA | |
|  | HLMP-0300 | High Efficiency Red (626 nm) | Rectangular | Red Diffused | 2.5 mcd @ 20 mA | 100° | 2.5 Volts @ 20 mA | 214 |
| | HLMP-0301 | | | | 5.0 mcd @ 20 mA | | | |
| | HLMP-0400 | Yellow (585 nm) | | Yellow Diffused | 2.5 mcd @ 20 mA | | | |
| | HLMP-0401 | | | | 5.0 mcd @ 20 mA | | | |
| | HLMP-0503 | Green (569 nm) | | Green Diffused | 2.5 mcd @ 20 mA | | 2.3 Volts @ 20 mA | 186, 214 |
| | HLMP-0504 | | | | 5.0 mcd @ 20 mA | | | |
|  | HLMP-6300 (5082-4160) | High Efficiency Red (626 nm) | Subminiature | Red Diffused | 3.0 mcd @ 10 mA | 80° | 2.2 Volts @ 10 mA | 221 |
| | HLMP-6400 (5082-4150) | Yellow (585 nm) | | Yellow Diffused | | 90° | | |
| | HLMP-6500 (5082-4190) | Green (569 nm) | | Green Diffused | | 70° | 2.3 Volts @ 10 mA | |

## igh Efficiency Red, Yellow, High Performance Green LED Lamps (continued)

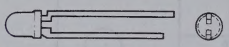
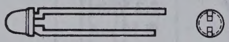
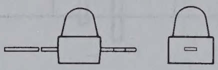
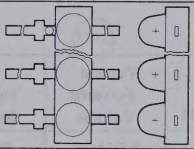
| Device | | Description | | | | Typical Luminous Intensity | 2Θ½[1] | Typical Forward Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color[2] | Package | * | Lens | | | | |
|  | HLMP-6653 | High Efficiency Red (626 nm) | Sub-miniature Array | 3 | Red Diffused | 3.0 mcd @ 10 mA | 80° | 2.2 Volts @ 10 mA | 217 |
| | HLMP-6654 | | | 4 | | | | | |
| | HLMP-6655 | | | 5 | | | | | |
| | HLMP-6656 | | | 6 | | | | | |
| | HLMP-6658 | | | 8 | | | | | |
| | HLMP-6753 | Yellow (585 nm) | Sub-miniature Array | 3 | Yellow Diffused | | 90° | | |
| | HLMP-6754 | | | 4 | | | | | |
| | HLMP-6755 | | | 5 | | | | | |
| | HLMP-6756 | | | 6 | | | | | |
| | HLMP-6758 | | | 8 | | | | | |
| | HLMP-6853 | Green (569 nm) | Sub-miniature Array | 3 | Green Diffused | | 70° | 2.3 Volts @ 10 mA | |
| | HLMP-6854 | | | 4 | | | | | |
| | HLMP-6855 | | | 5 | | | | | |
| | HLMP-6856 | | | 6 | | | | | |
| | HLMP-6858 | | | 8 | | | | | |

*Array Length

## Red LED Lamps

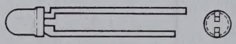
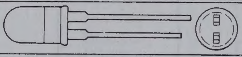
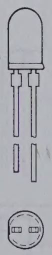
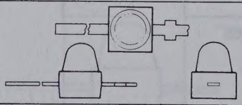
| Device | | Description | | | Typical Luminous Intensity | 2Θ½[1] | Typical Forward Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color[2] | Package | Lens | | | | |
|  | HLMP-3000 (5082-4850) | Red (640 mm) | T-1¾[3] | Red Diffused | 2.0 mcd @ 20 mA | 95° | 1.6 Volts @ 20 mA | 203 |
| | HLMP-3001 (5082-4855) | | | | 4.0 mcd @ 20 mA | | | |
| | HLMP-3002 | | | | 3.0 mcd @ 20 mA | 90° | | |
| | HLMP-3050 | | | Red Tinted Non-Diffused | 2.5 mcd @ 20 mA | 24° | | |
|  | HLMP-0101 (5082-4440) | | | Red Diffused | 1.0 mcd @ 20 mA | 75° | | 205 |
| | HLMP-0102 (5082-4403) | | | | 2.0 mcd @ 20 mA | | | |
| | HLMP-0140 (5082-4444) [4] | | | | 1.0 mcd @ 20 mA | | | |
| | HLMP-0141 (5082-4415) [4] | | | | 2.0 mcd @ 20 mA | | | |
|  | HLMP-0200 (5082-4880) | | | | | 58° | | |
| | HLMP-0202 (5082-4882) | | | | 3.0 mcd @ 20 mA | | | |
| | HLMP-0220 (5082-4883) | | | Untinted Non-Diffused | 2.0 mcd @ 20 mA | 50° | | |
| | HLMP-0222 (5082-4885) | | | | 3.0 mcd @ 20 mA | | | |
| | HLMP-0240 (5082-4886) | | | Untinted Diffused | 2.0 mcd @ 20 mA | 65° | | |
| | HLMP-0242 (5082-4888) | | | | 3.0 mcd @ 20 mA | | | |
|  | HLMP-3200 (5082-4790) | | T-1¾ Low Profile | Red Diffused | 2.0 mcd @ 20 mA | 60° | | 197 |
| | HLMP-3201 (5082-4791) | | | | 4.0 mcd @ 20 mA | | | |

# Red LED Lamps (continued)

| Device | | Description | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color[2] | Package | Lens | Typical Luminous Intensity | 2Θ½[1] | Typical Forward Voltage | Page No. |
|  | HLMP-1000<br>(5082-4480) | Red<br>(640 nm) | T-1[4] | Red<br>Diffused | 1.0 mcd<br>@ 20 mA | 125° | 1.6 Volts<br>@ 20 mA | 212 |
| | HLMP-1002<br>(5082-4494) | | | | 2.5 mcd<br>@ 20 mA | | | |
| | HLMP-1080<br>(5082-4483) | | | Untinted<br>Diffused | 1.5 mcd<br>@ 20 mA | | | |
| | HLMP-1071<br>(5082-4486) | | | Untinted<br>Non-Diffused | 2.0 mcd<br>@ 20 mA | 80° | | |
|  | HLMP-1200<br>(5082-4487) | | T-1<br>Low Profile[4] | Untinted<br>Non-Diffused | 1.0 mcd<br>@ 20 mA | 120° | | |
| | HLMP-1201<br>(5082-4488) | | | | 2.5 mcd<br>@ 20 mA | | | |
|  | HLMP-6000<br>(5082-4100) | | Subminiature | Red<br>Diffused | 1.0 mcd<br>@ 10 mA | 45° | 1.6 Volts<br>@ 10 mA | 221 |
| | HLMP-6001<br>(5082-4101) | | | | 1.5 mcd<br>@ 10 mA | | | |
|  | HLMP-6203 | | Sub-Miniature 3* | Red<br>Diffused | 1.2 mcd<br>@ 10 mA | | | 217 |
| | HLMP-6204 | | 4* | | | | | |
| | HLMP-6205 | | 5* | | | | | |
| | HLMP-6206 | | 6* | | | | | |
| | HLMP-6208 | | 8* | | | | | |

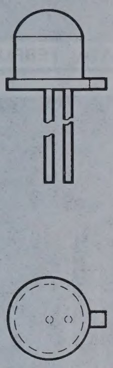
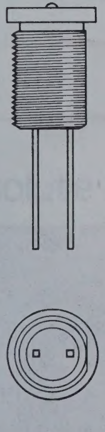
*Array Length

# Integrated LED Lamps

| Device | | Description | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color[2] | Package | Lens | Typical Luminous Intensity | 2Θ½[1] | Typical Forward Voltage | Page No. |
|  | HLMP-1120<br>(5082-4468) | Red<br>(640 nm) | T-1[4] | Clear<br>Diffused | 1.5 mcd<br>@ 5V | 70° | 16 mA<br>@ 5V | 227 |
| | HLMP-1142<br>(5082-4732) | | | Red<br>Diffused | 0.7 mcd<br>@ 2.75V | 95° | 13 mA<br>@ 2.75V | 231 |
|  | HLMP-0280<br>(5082-4860) | | T-1¾[3] | | 2.0 mcd<br>@ 5V | 58° | 16 mA<br>@ 5V | 227 |
|  | HLMP-3105 | | | | 2.0 mcd<br>@ 5V | 90° | 20 mA | |
| | HLMP-3112 | | | | | | 14 mA<br>@ 12V | |
| | HLMP-3600 | High Eff.<br>Red<br>(626 nm) | | | 4.0 mcd<br>@ 5V | | 15 mA | |
| | HLMP-3650 | Yellow<br>(585 nm) | | Yellow<br>Diffused | | | | |
| | HLMP-3680 | Green<br>(569 nm) | | Green<br>Diffused | | | | |
|  | HLMP-6600 | High<br>Efficiency<br>Red<br>(626 nm) | Subminiature<br>Radial Leads | Red<br>Diffused | 2.4 mcd<br>@ 5V | | 9.6 mA<br>@ 5V | 225 |
| | HLMP-6620 | | | | 0.6 mcd<br>@ 5V | | 3.5 mA<br>@ 5V | |

NOTES:
1. Θ½ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. Dominant Wavelength
3. Panel Mountable. For Panel Mounting Kit, see page 239.
4. PC Board Mountable
5. Military Approved and qualified for High Reliability Applications.
6. Wire Wrappable Leads.

# Hermetically Sealed and High Reliability LED Lamps

| Device | | Description | | | Minimum Luminous Intensity | 2Θ½ [1] | Typical Forward Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color [2] | Package | Lens | | | | |
|  | 1N5765 | Red (640 nm) | Hermetic/T0-46[3] | Red Diffused | 0.5 mcd @ 20mA | 70° | 1.6 Volts @ 20mA | 233 |
| | JAN1N5765[4] | | | | | | | |
| | JANTX1N5765[4] | | | | | | | |
| | 1N6092 | High Efficiency Red (626 nm) | | | 1.0 mcd @ 20mA | | 2.0 Volts @ 20mA | |
| | JAN1N6092[4] | | | | | | | |
| | JANTX1N6092[4] | | | | | | | |
| | 1N6093 | Yellow (585 nm) | | Yellow Diffused | | | | |
| | JAN1N6093[4] | | | | | | | |
| | JANTX1N6093[4] | | | | | | | |
| | 1N6094 | Green (572 nm) | | Green Diffused | 0.8 mcd @ 25mA | | 2.1 Volts @ 20mA | |
| | JAN1N6094[4] | | | | | | | |
| | JANTX1N6094[4] | | | | | | | |
|  | 5082-4787 | Red (640 nm) | Panel Mount Version | Red Diffused | 0.5 mcd @ 20mA | | 1.6 Volts @ 20mA | |
| | HLMP-0930 | | | | | | | |
| | HLMP-0931 | | | | | | | |
| | 5082-4687 | High Efficiency Red (626 nm) | | | 1.0 mcd @ 20mA | | 2.0 Volts @ 20mA | |
| | M19500/519-01[4] | | | | | | | |
| | M19500/519-02[4] | | | | | | | |
| | 5082-4587 | Yellow (585 nm) | | Yellow Diffused | | | | |
| | M19500/520-01[4] | | | | | | | |
| | M19500/520-02[4] | | | | | | | |
| | 5082-4987 | Green (572 nm) | | Green Diffused | 0.8 mcd @ 25mA | | 2.1 Volts @ 20mA | |
| | M19500/521-01[4] | | | | | | | |
| | M19500/521-02[4] | | | | | | | |

NOTES:
1. Θ½ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. Peak Wavelength.
3. PC Board Mountable.
4. Military Approved and qualified for High Reliability Applications.

HEWLETT PACKARD

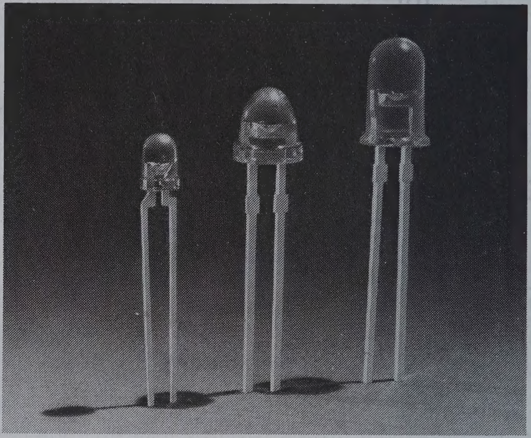
# ULTRA-BRIGHT LED LAMP SERIES

## T-1 3/4 HLMP-3750,-3850,-3950
## T-1 3/4 LOW PROFILE HLMP-3390,-3490,-3590
## T-1 HLMP-1340,-1440,-1540

TECHNICAL DATA FEBRUARY 1982

## Features

- **IMPROVED BRIGHTNESS**
- **IMPROVED COLOR PERFORMANCE**
- **AVAILABLE IN POPULAR T-1 and T-1 3/4 PACKAGES**
- **NEW STURDY LEADS**
- **IC COMPATIBLE/LOW CURRENT CAPABILITY**
- **RELIABLE AND RUGGED**
- **CHOICE OF 3 BRIGHT COLORS**
  **High Efficiency Red**
  **High Brightness Yellow**
  **High Performance Green**



## Description

These clear, non-diffused lamps out perform conventional LED lamps. By utilizing new higher intensity material, we achieve superior product performance.

The HLMP-3750/-3390/-1340 Series Lamps are Gallium Arsenide Phosphide on Gallium Phosphide red light emitting diodes. The HLMP-3850/-3490/-1440 Series are Gallium Arsenide Phosphide on Gallium Phosphide yellow light emitting diodes. The HLMP-3950/-3590/-1540 Series lamps are Gallium Phosphide green light emitting diodes.

## Applications

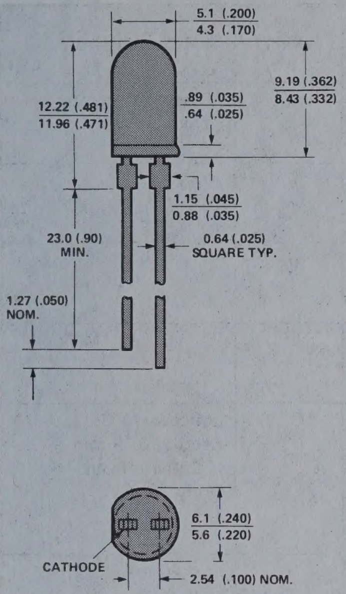
- **LIGHTED SWITCHES**
- **BACKLIGHTING FRONT PANELS**
- **LIGHT PIPE SOURCES**
- **KEYBOARD INDICATORS**

## Axial Luminous Intensity and Viewing Angle @ 25°C

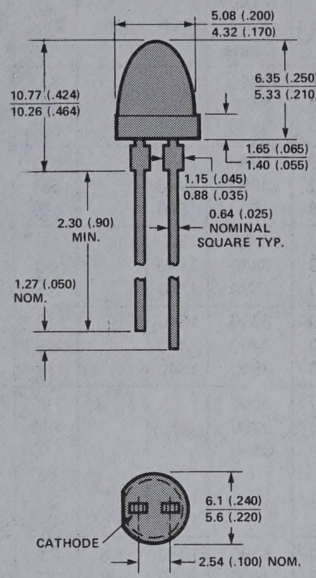
| Part Number HLMP- | Package Description | Color | $I_V$ (mcd) @ 20 mA DC Min. | Typ. | 2Θ 1/2 Note 1. | Package Outline |
|---|---|---|---|---|---|---|
| 3750 | T-1 3/4 | Red | 80 | 125 | 24° | A |
| 3850 | | Yellow | 80 | 140 | 24° | A |
| 3950 | | Green | 80 | 120 | 24° | A |
| 3390 | T-1 3/4 Low Profile | Red | 35 | 55 | 32° | B |
| 3490 | | Yellow | 35 | 55 | 32° | B |
| 3590 | | Green | 35 | 55 | 32° | B |
| 1340 | T-1 | Red | 24 | 35 | 45° | C |
| 1440 | | Yellow | 24 | 35 | 45° | C |
| 1540 | | Green | 24 | 35 | 45° | C |

**NOTE:**
1. Θ1/2 is the typical off-axis angle at which the luminous intensity is half the axial luminous intensity.

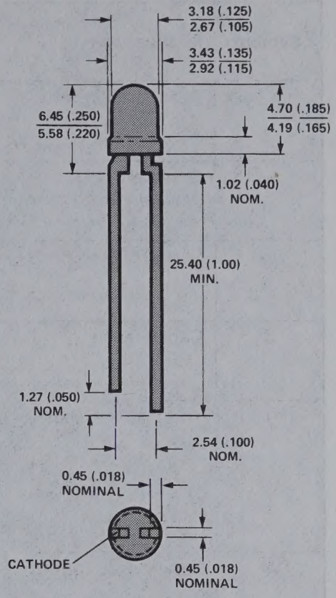
# Package Dimensions


5.1 (.200)
4.3 (.170)
12.22 (.481)
11.96 (.471)
.89 (.035)
.64 (.025)
9.19 (.362)
8.43 (.332)
1.15 (.045)
0.88 (.035)
23.0 (.90)
MIN.
0.64 (.025)
SQUARE TYP.
1.27 (.050)
NOM.
6.1 (.240)
5.6 (.220)
CATHODE
2.54 (.100) NOM.

**PACKAGE OUTLINE "A"**
**HLMP-3750, 3850, 3950**


5.08 (.200)
4.32 (.170)
10.77 (.424)
10.26 (.464)
6.35 (.250)
5.33 (.210)
1.65 (.065)
1.40 (.055)
1.15 (.045)
0.88 (.035)
2.30 (.90)
MIN.
0.64 (.025)
NOMINAL
SQUARE TYP.
1.27 (.050)
NOM.
6.1 (.240)
5.6 (.220)
CATHODE
2.54 (.100) NOM.

**PACKAGE OUTLINE "B"**
**HLMP-3390, 3490, 3590**


3.18 (.125)
2.67 (.105)
3.43 (.135)
2.92 (.115)
6.45 (.250)
5.58 (.220)
4.70 (.185)
4.19 (.165)
1.02 (.040)
NOM.
25.40 (1.00)
MIN.
1.27 (.050)
NOM.
2.54 (.100)
NOM.
0.45 (.018)
NOMINAL
CATHODE
0.45 (.018)
NOMINAL

**PACKAGE OUTLINE "C"**
**HLMP-1340, 1440, 1540**

**NOTES:**

1. All dimensions are in millimeters (inches).
2. Silver plated leads. See Application Bulletin 3.
3. An epoxy meniscus may extend about 1mm (0.40") down the leads.

---

# Absolute Maximum Ratings at $T_A = 25°C$

| Parameter | Red | Yellow | Green | Units |
|---|---|---|---|---|
| Peak Forward Current | 90 | 60 | 90 | mA |
| Average Forward Current[1] | 25 | 20 | 25 | mA |
| DC Current[2] | 30 | 20 | 30 | mA |
| Power Dissipation[3] | 135 | 85 | 135 | mW |
| Operating and Storage Temperature Range | -55° C to +100° C | | | |
| Lead Soldering Temperature (1.6 mm (0.063 in.) from Body) | 260° C for 5 seconds | | | |

**NOTES:**

1. See Figure 2 to establish pulsed operating conditions.
2. For Red and Green series derate linearly from 50° C at 0.5 mA/° C. For Yellow series derate linearly from 50° C at 0.2 mA/° C.
3. For Red and Green series derate power linearly from 25° C at 1.8 mW/° C. For Yellow series derate power linearly from 50° C at 1.6 mW/° C.

# Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Description | T-1 3/4 | T-1 3/4 Low Dome | T-1 | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|
| $\lambda_p$ | Peak Wavelength | 3750 | 3390 | 1340 | | 635 | | nm | Measurement at Peak |
| | | 3850 | 3490 | 1440 | | 583 | | | |
| | | 3950 | 3590 | 1540 | | 565 | | | |
| $\lambda_d$ | Dominant Wavelength | 3750 | 3390 | 1340 | | 629 | | nm | Note 1 |
| | | 3850 | 3990 | 1440 | | 585 | | | |
| | | 3950 | 3590 | 1540 | | 569 | | | |
| $T_S$ | Speed of Response | 3750 | 3390 | 1340 | | 90 | | ns | |
| | | 3850 | 3490 | 1440 | | 90 | | | |
| | | 3950 | 3590 | 1540 | | 500 | | | |
| C | Capacitance | 3750 | 3390 | 1340 | | 16 | | pF | $V_F = 0$; f = 1 MHz |
| | | 3850 | 3490 | 1440 | | 18 | | | |
| | | 3950 | 3590 | 1540 | | 18 | | | |
| $\Theta_{JC}$ | Thermal Resistance | 3750 | 3390 | | | 140 | | °C/W | Junction to Cathode Lead at 0.79 mm (0.031 in.) from Body |
| | | 3850 | 3490 | | | 140 | | | |
| | | 3950 | 3590 | | | 140 | | | |
| | | | | 1340 | | 95 | | | |
| | | | | 1440 | | 95 | | | |
| | | | | 1540 | | 95 | | | |
| $V_F$ | Forward Voltage | 3750 | 3390 | 1340 | 1.6 | 2.2 | 3.0 | V | $I_F = 20$ mA (Figure 3) |
| | | 3850 | 3490 | 1440 | 1.6 | 2.2 | 3.0 | | |
| | | 3950 | 3590 | 1540 | 1.6 | 2.3 | 3.0 | | |
| $BV_R$ | Reverse Breakdown Voltage | 3750 | 3390 | 1340 | 5.0 | | | V | $I_F = 100\ \mu A$ |
| | | 3850 | 3490 | 1440 | | | | | |
| | | 3950 | 3590 | 1540 | | | | | |
| $\eta_V$ | Luminous Efficacy | 3750 | 3390 | 1340 | | 147 | | lumens/watt | Note 2 |
| | | 3850 | 3490 | 1440 | | 570 | | | |
| | | 3950 | 3590 | 1540 | | 630 | | | |

**NOTES:**

1. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
2. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

---

## Red, Yellow and Green

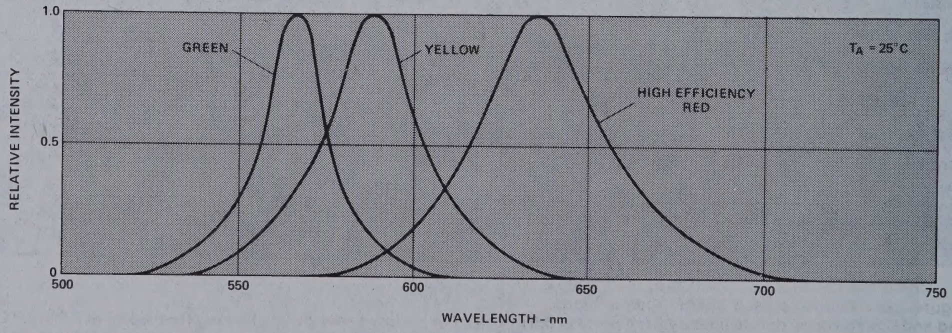


**Figure 1. Relative Intensity vs. Wavelength.**

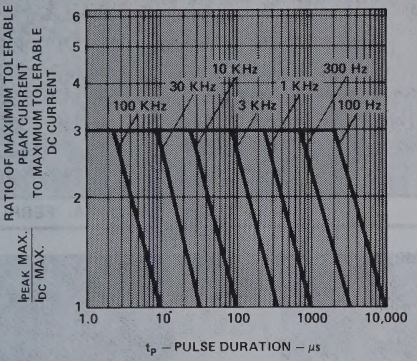


**Figure 2. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings.)**

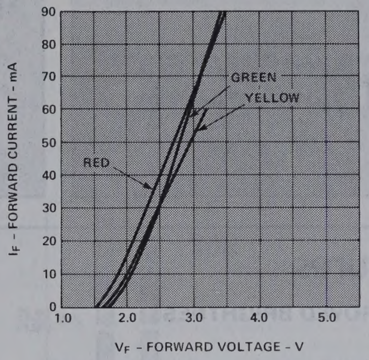


**Figure 3. Forward Current vs. Forward Voltage.**

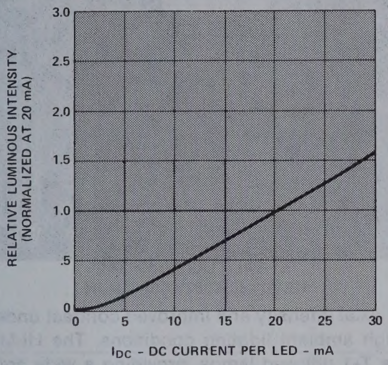


**Figure 4. Relative Luminous Intensity vs. Forward Current.**

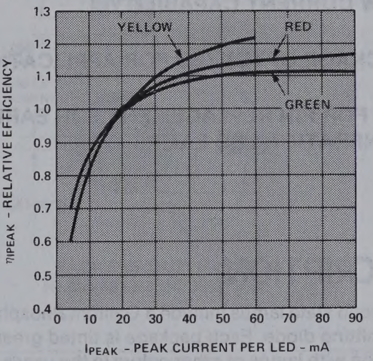


**Figure 5. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.**

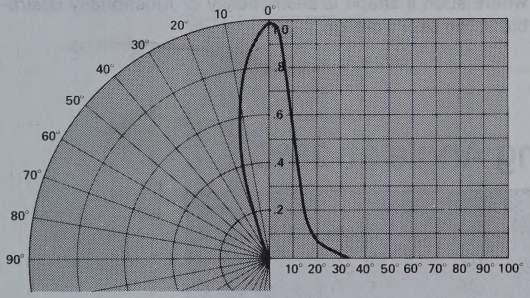


**Figure 6. Relative Luminous Intensity vs. Angular Displacement. T-1 3/4 Lamp.**

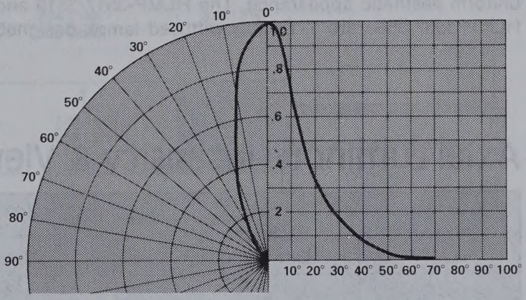


**Figure 7. Relative Luminous Intensity vs. Angular Displacement. T-1 3/4 Low Profile Lamp.**

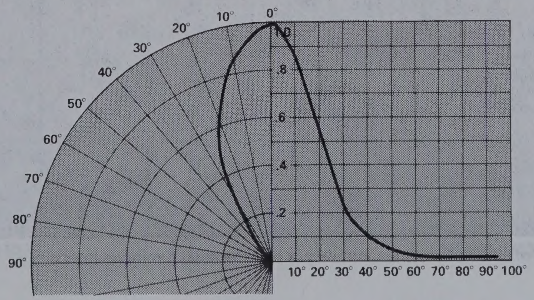


**Figure 8. Relative Luminous Intensity vs. Angular Displacement. T-1 Lamp.**

**HEWLETT PACKARD**

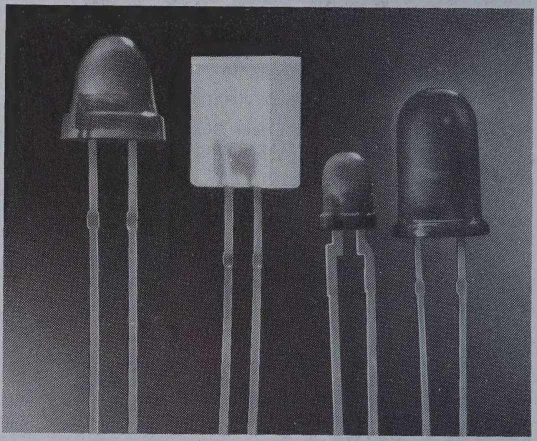
# HIGH PERFORMANCE LED GREEN LAMPS

| | |
|---|---|
| T-1¾ Diffused | HLMP-3502-3507 |
| T-1¾ Non-Diffused | HLMP-3517-3519 |
| T-1¾ Low Profile Diffused | HLMP-3553-3554 |
| T-1¾ Low Profile Non-Diffused | HLMP-3567-3568 |
| T-1 Diffused | HLMP-1503-1523 |
| Rectangular | HLMP-0503-0504 |

TECHNICAL DATA FEBRUARY 1982

## Features

- IMPROVED BRIGHTNESS
- IMPROVED COLOR PERFORMANCE
- LOW CURRENT CAPABILITY
- PACKAGE OPTIMIZED FOR APPLICATION
- PIN FOR PIN REPLACEMENT FOR EARLIER GENERATION LED LAMPS



## DESCRIPTION

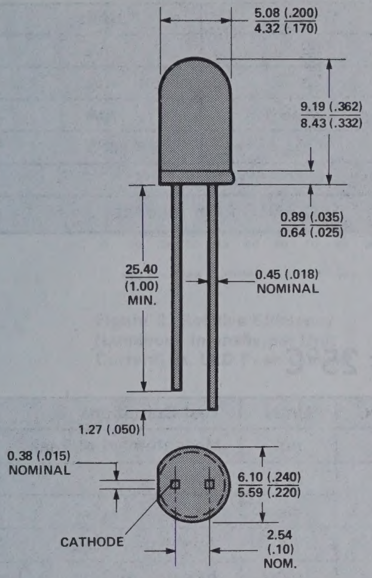
These solid state lamps include a Gallium Phosphide green light emitting diode. Each package is tinted green to avoid confusion with lamps of other colors in the user's assembly process. The HLMP-3502/3507 and HLMP-3553/3554 are T-1¾ diffused lamps designed for wide viewing angle and uniform aesthetic appearance. The HLMP-3517/3519 and HLMP-3567/3568 are T-1¾ non-diffused lamps designed for high axial intensity and improved contrast under especially high ambient lighting conditions. The HLMP-1503/1523 are T-1 diffused lamps, providing a wide angle product for smaller space applications. The HLMP-0503/0504 are rectangular lamps designed for wide viewing angle where such a shape is aesthetically or functionally desirable in the user's design.

## Axial Luminous Intensity & Viewing Angle at 25°C

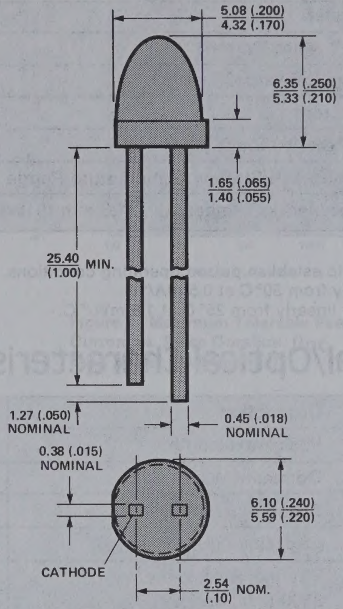
| Part Number HLMP- | Package Description | Iv (mcd) @ 20 mA DC | | $2\Theta_{1/2}$ (Note 1) | Package Outline |
|---|---|---|---|---|---|
| | | Min. | Typ. | | |
| 3502 | T-1¾ | 3 | 6 | 75° | A |
| 3507 | T-1¾ | 7 | 12 | 75° | A |
| 3517 | T-1¾ | 12 | 25 | 24° | A |
| 3519 | T-1¾ | 30 | 50 | 24° | A |
| 3553 | T-1¾ Low Profile | 3 | 8 | 50° | B |
| 3554 | T-1¾ Low Profile | 10 | 15 | 50° | B |
| 3567 | T-1¾ Low Profile | 8 | 15 | 40° | B |
| 3568 | T-1¾ Low Profile | 20 | 35 | 40° | B |
| 1503 | T-1 | 2 | 5 | 60° | C |
| 1523 | T-1 | 5 | 10 | 60° | C |
| 0503 | Rectangular | 1 | 2.5 | 100° | D |
| 0504 | Rectangular | 3 | 5 | 100° | D |

Note: 1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.

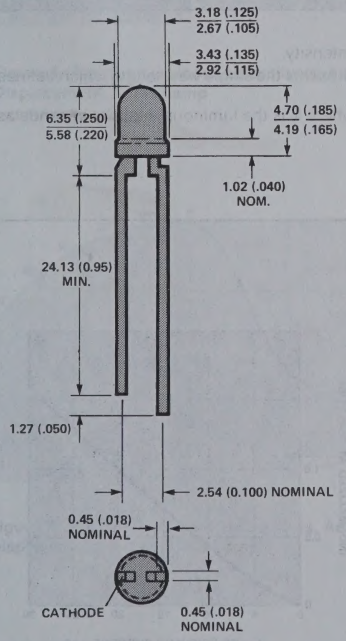
# Package Dimensions


5.08 (.200)
4.32 (.170)
9.19 (.362)
8.43 (.332)
0.89 (.035)
0.64 (.025)
25.40
(1.00)
MIN.
0.45 (.018)
NOMINAL
1.27 (.050)
0.38 (.015)
NOMINAL
6.10 (.240)
5.59 (.220)
CATHODE
2.54
(.10)
NOM.

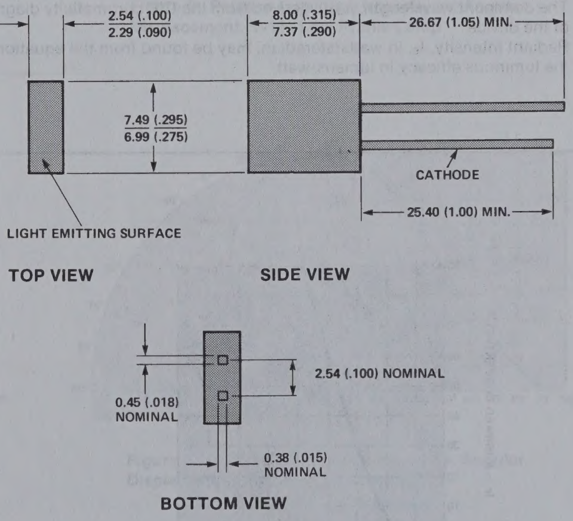
**PACKAGE OUTLINE "A"**
**HLMP-3502/3507/3517/3519**


5.08 (.200)
4.32 (.170)
6.35 (.250)
5.33 (.210)
1.65 (.065)
1.40 (.055)
25.40
(1.00)
MIN.
1.27 (.050)
NOMINAL
0.45 (.018)
NOMINAL
0.38 (.015)
NOMINAL
6.10 (.240)
5.59 (.220)
CATHODE
2.54
(.10)
NOM.

**PACKAGE OUTLINE "B"**
**HLMP-3553/3554/3567/3568**


3.18 (.125)
2.67 (.105)
3.43 (.135)
2.92 (.115)
6.35 (.250)
5.58 (.220)
4.70 (.185)
4.19 (.165)
1.02 (.040)
NOM.
24.13 (0.95)
MIN.
1.27 (.050)
2.54 (0.100) NOMINAL
0.45 (.018)
NOMINAL
CATHODE
0.45 (.018)
NOMINAL

**PACKAGE OUTLINE "C"**
**HLMP-1503/1523**


2.54 (.100)
2.29 (.090)
8.00 (.315)
7.37 (.290)
26.67 (1.05) MIN.
7.49 (.295)
6.99 (.275)
CATHODE
25.40 (1.00) MIN.
LIGHT EMITTING SURFACE
TOP VIEW
SIDE VIEW
2.54 (.100) NOMINAL
0.45 (.018)
NOMINAL
0.38 (.015)
NOMINAL
BOTTOM VIEW

**PACKAGE OUTLINE "D"**
**HLMP-0503/0504**

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

# Absolute Maximum Ratings at $T_A = 25°C$

| Parameter | Green | Units |
|---|---|---|
| Peak Forward Current | 90 | mA |
| Average Forward Current[1] | 25 | mA |
| DC Current[2] | 30 | mA |
| Power Dissipation[3] | 135 | mW |
| Operating and Storage Temperature Range | -55° C to +100° C | |
| Lead Soldering Temperature [1.6 mm (0.063 in.) from Body] | 260° C for 5 seconds | |

**NOTES:**
1. See Figure 4 to establish pulsed operating conditions.
2. Derate linearly from 50° C at 0.5 mA/° C.
3. Derate power linearly from 25° C at 1.8 mW/° C.

# Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Description | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $\lambda_{PEAK}$ | Peak Wavelength | | 565 | | nm | Measurement at Peak |
| $\lambda_d$ | Dominant Wavelength | | 569 | | nm | Note 2 |
| $\tau_s$ | Speed of Response | | 500 | | ns | |
| C | Capacitance | | 18 | | pF | $V_F = 0$; f = 1 MHz |
| $\Theta_{JC}$ | Thermal Resistance<br>3500/0500 Series<br>1500 Series | | <br>145<br>95 | | °C/W | Junction to Cathode Lead at 0.79mm (0.031 in.) from Body |
| $V_F$ | Forward Voltage | 1.6 | 2.3 | 3.0 | V | $I_F = 20$ mA, Figure 1 |
| $BV_R$ | Reverse Breakdown Voltage | 5.0 | | | V | $I_R = 100\ \mu A$ |
| $\eta_v$ | Luminous Efficacy | | 630 | | lm/W | Note 3 |

Notes:
1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

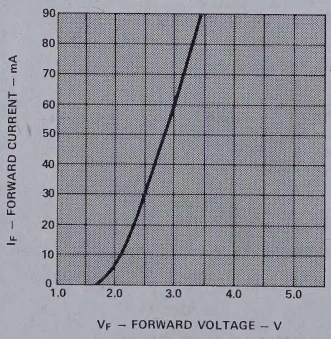


**Figure 1. Forward Current vs. Forward Voltage**

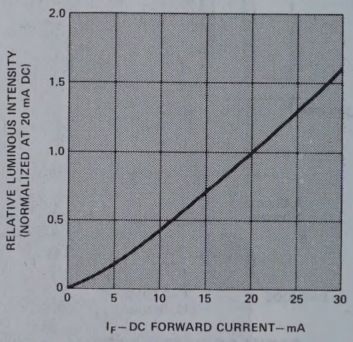


**Figure 2. Relative Luminous Intensity vs. DC Forward Current**

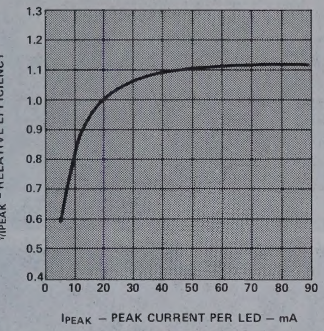


**Figure 3. Relative Efficiency (Luminous Intensity per Unit Current) vs. LED Peak Current**

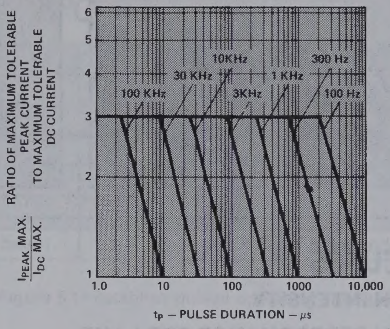


**Figure 4. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

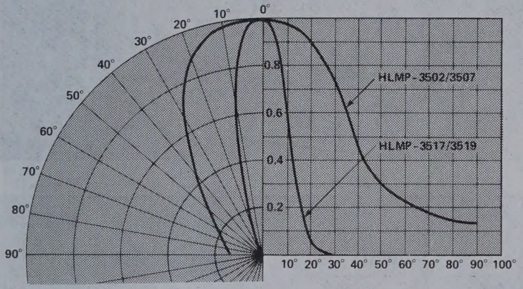


**Figure 5. Relative Luminous Intensity vs. Angular Displacement. T-1¾ Lamp**

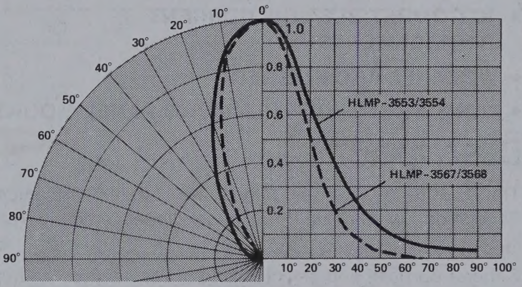


**Figure 6. Relative Luminous Intensity vs. Angular Displacement. T-1¾ Low Profile Lamp**

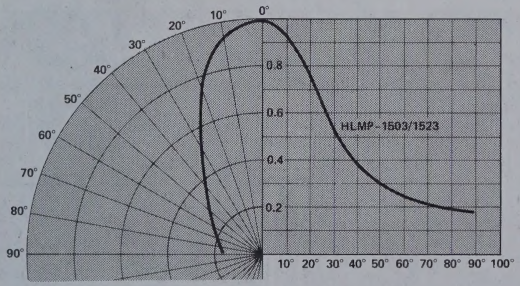


**Figure 7. Relative Luminous Intensity vs. Angular Displacement. T-1 Diffused Lamp**

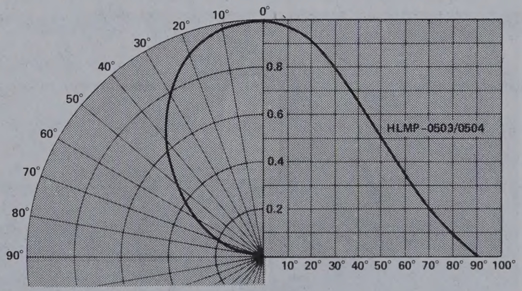


**Figure 8. Relative Luminous Intensity vs. Angular Displacement. Rectangular Lamp**

**For a Detailed Explanation on the Use of Data Sheet Information and Recommended Soldering Procedures, see Application Note 1005.**

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# HIGH BRIGHTNESS LED LAMPS

## HIGH EFFICIENCY RED • HLMP-4600 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

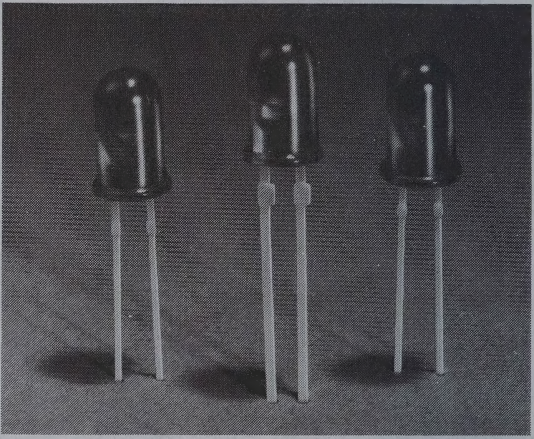
- HIGH INTENSITY
- HIGH PERFORMANCE RED LAMP
- POPULAR T-1¾ PACKAGE
- LIGHT OUTPUT CATEGORIES
- DIFFUSED LENS/NARROW VIEWING ANGLE
- GENERAL PURPOSE AND WIRE WRAPPABLE LEADS
- IC COMPATIBLE/LOW CURRENT REQUIREMENTS
- RELIABLE AND RUGGED
- COMPATIBLE WITH HLMP-0103 PANEL MOUNT

## Description

The HLMP-4600 Series lamps are Gallium Arsenide Phosphide on Gallium Phosphide diodes emitting red light.

General purpose and selected brightness versions of the diffused lens type are available.

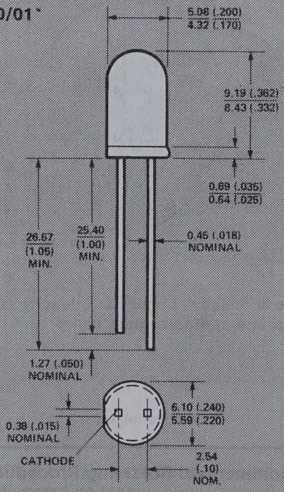
The HLMP-4600/-4601 are high performance red T-1 3/4 lamps made to be used in illuminator and general purpose applications. The HLMP-4610 is a 4600 lamp with .025" leads.



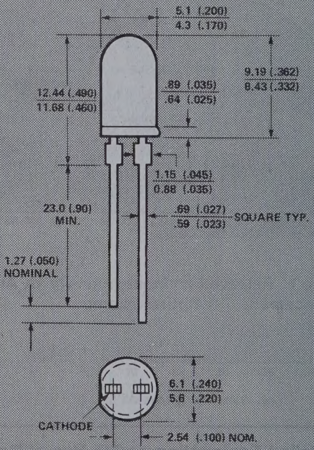
| Part Number HLMP- | Application | Lens | Color |
|---|---|---|---|
| 4600/<br>4610 | Indicator — General Purpose | Tinted Diffused | High Efficiency Red |
| 4601 | Indicator — High Brightness | Tinted Diffused | High Efficiency Red |

## Package Dimensions

**HLMP-4600/01***


5.08 (.200)
4.32 (.170)
9.19 (.362)
8.43 (.332)
0.89 (.035)
0.64 (.025)
26.67 (1.05) MIN.
25.40 (1.00) MIN.
0.45 (.018) NOMINAL
1.27 (.050) NOMINAL
0.38 (.015) NOMINAL
6.10 (.240)
5.59 (.220)
CATHODE
2.54 (.10) NOM.

**HLMP-4610**


5.1 (.200)
4.3 (.170)
12.44 (.490)
11.68 (.460)
.89 (.035)
.64 (.025)
9.19 (.362)
8.43 (.332)
1.15 (.045)
0.88 (.035)
23.0 (.90) MIN.
.69 (.027)
.59 (.023)
SQUARE TYP.
1.27 (.050) NOMINAL
6.1 (.240)
5.6 (.220)
CATHODE
2.54 (.100) NOM.

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

# Absolute Maximum Ratings at $T_A$ = 25°C

| Parameter | 4600 Series | Units |
|---|---|---|
| Power Dissipation[1] | 135 | mW |
| DC Forward Current[2] | 30 | mA |
| Average Forward Current[3] | 25 | mA |
| Peak Operating Forward Current | 90 | mA |
| Operating and Storage Temperature Range | -55° C to +100° C | |
| Lead Solder Temperature (1.6 mm [0.063 inch] below package base) | 260° C for 5 seconds | |

**NOTES:**

1. Derate from 25° C at 1.8 mW/° C.
2. Derate from 50° C at 0.5 mA/° C.
3. See Figure 5 to establish pulsed operating conditions.

# Electrical Characteristics at $T_A$ = 25° C

| Symbol | Description | Device 5082- | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| $I_V$ | Luminous Intensity | 4600/10 | 2.0 | 4.0 | | mcd | $I_F = 10mA$ (Fig. 3) |
| | | | | 10.0 | | mcd | $I_F = 20mA$ |
| | | 4601 | 4.0 | 8.0 | | mcd | $I_F = 10mA$ |
| | | | | 20.0 | | mcd | $I_F = 20mA$ |
| $2\Theta_{1/2}$ | Viewing Angle | 4600/01/10 | | 32 | | Deg | $I_F = 10mA$<br>See Note 1 (Fig. 6) |
| $\lambda_{PEAK}$ | Peak Wavelength | 4600/01/10 | | 635 | | nm | Measurement at Peak (Fig. 1) |
| $\lambda_d$ | Dominant Wavelength | 4600/01/10 | | 626 | | nm | See Note 2 |
| $\tau_S$ | Speed of Response | 4600/01/10 | | 90 | | ns | |
| C | Capacitance | 4600/01/10 | | 16 | | pF | $V_F = 0$, f = 1 MHz |
| $\Theta_{JC}$ | Thermal Resistance | 4600/01/10 | | 135 | | °C/W | Junction to Cathode Lead at Seating Plane |
| $V_F$ | Forward Voltage | 4600/01/10 | 1.5 | 2.2 | 3.0 | V | $I_F = 10mA$ (Fig. 2) |
| $V_{BR}$ | Reverse Breakdown Voltage | 4600/01/10 | 5.0 | | | V | $I_R = 100\mu A$ |
| $\eta_V$ | Luminous Efficacy | 4600/01/10 | | 147 | | lumens/ watt | See Note 3 |

Notes:

1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

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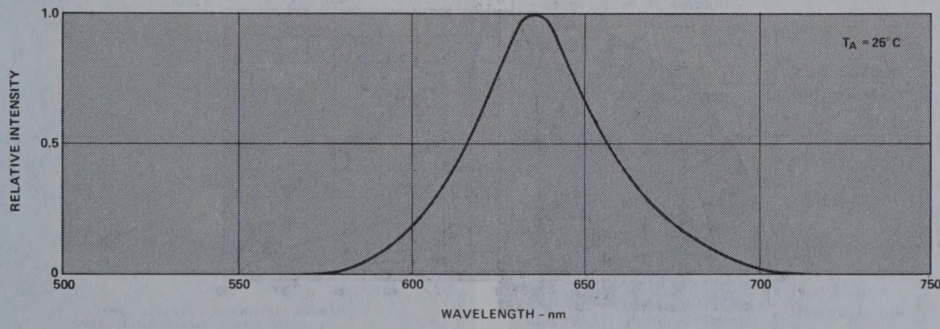

**Figure 1. Relative Intensity vs. Wavelength**

# High Efficiency Red HLMP-4600 Series

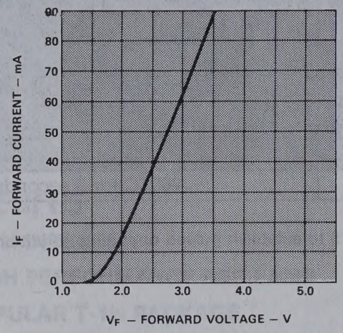

Figure 2. Forward Current vs Forward Voltage Characteristics.

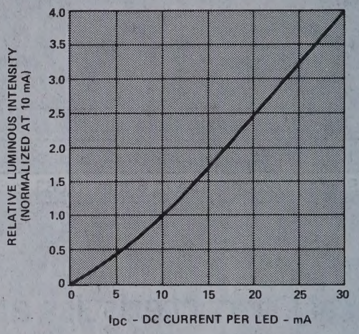

Figure 3. Relative Luminous Intensity vs. DC Forward Current.

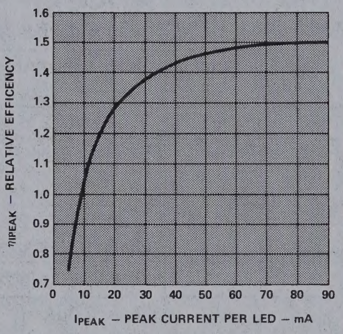

Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. LED Peak Current.

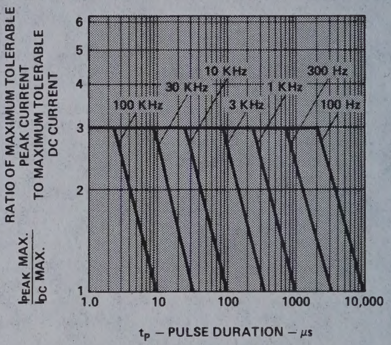

Figure 5. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings).

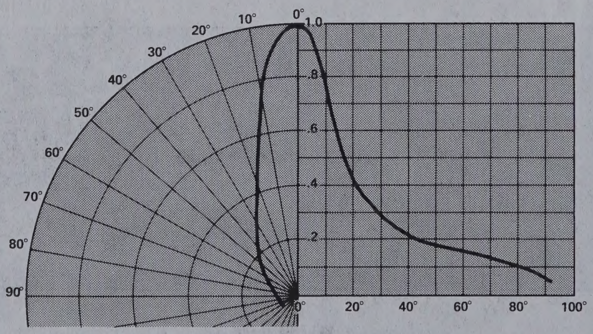

Figure 6. Relative Luminous Intensity vs. Angular Displacement

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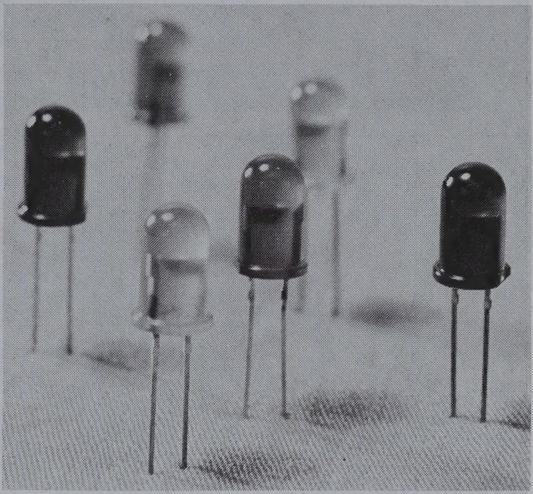
# T-1 3/4 (5mm) SOLID STATE LAMPS

## HIGH EFFICIENCY RED ● HLMP-3300 SERIES (5082-4650)
## YELLOW ● HLMP-3400 SERIES (5082-4550)
## HIGH PERFORMANCE GREEN ● HLMP-3500 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **HIGH INTENSITY**
- **CHOICE OF 3 BRIGHT COLORS**
  - **High Efficiency Red**
  - **Yellow**
  - **High Performance Green**
- **POPULAR T-1¾ DIAMETER PACKAGE**
- **LIGHT OUTPUT CATEGORIES**
- **WIDE VIEWING ANGLE AND NARROW VIEWING ANGLE TYPES**
- **GENERAL PURPOSE LEADS**
- **IC COMPATIBLE/LOW CURRENT REQUIREMENTS**
- **RELIABLE AND RUGGED**

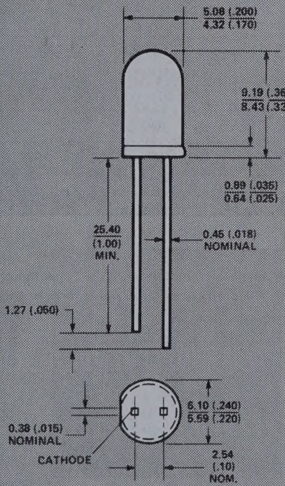


## Description

The HLMP-3300 and the HLMP-3400 Series lamps are Gallium Arsenide Phosphide on Gallium Phosphide diodes emitting red and yellow light respectively. The HLMP-3500 Series lamps are green light emitting Gallium Phosphide diodes.

General purpose and selected brightness versions of both the diffused and non-diffused lens type are available in each family.

## Package Dimensions



NOTES.
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

| Part Number HLMP- (5082-) | Application | Lens | Color |
|---|---|---|---|
| **3300**<br>(4650) | Indicator - General Purpose | Diffused Wide Angle | High Efficiency Red |
| **3301**<br>(4655) | Indicator - High Ambient | | |
| **3315**<br>(4657) | Illuminator/Point Source | Non Diffused Narrow Angle | |
| **3316**<br>(4658) | Illuminator/High Brightness | | |
| **3400**<br>(4550) | Indicator General Purpose | Diffused Wide Angle | Yellow |
| **3401**<br>(4555) | Indicator - High Ambient | | |
| **3415**<br>(4557) | Illuminator/Point Source | Non Diffused Narrow Angle | |
| **3416**<br>(4558) | Illuminator/High Brightness | | |
| **3502** | Indicator - General Purpose | Diffused Wide Angle | Green |
| **3507** | Indicator - High Ambient | | |
| **3517** | Illuminator/Point Source | Non Diffused Narrow Angle | |
| **3519** | Illuminator/High Brightness | | |

# Electrical Characteristics at $T_A = 25°C$

| Symbol | Description | Device HLMP- | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| $I_V$ | Luminous Intensity | 3300<br>3301<br>3315<br>3316 | 2.0<br>4.0<br>12.0<br>20.0 | 3.5<br>7.0<br>18.0<br>30.0 | | mcd | $I_F = 10$ mA (Figure 8) |
| | | 3400<br>3401<br>3415<br>3416 | 2.0<br>4.0<br>10.0<br>20.0 | 4.0<br>8.0<br>18.0<br>30.0 | | mcd | $I_F = 10$ mA (Figure 8) |
| | | 3502<br>3507<br>3517<br>3519 | 3.0<br>7.0<br>12.0<br>30.0 | 6.0<br>12.0<br>25.0<br>50.0 | | mcd | $I_F = 20$ mA (Figure 13) |
| $2\Theta$ 1/2 | Including Angle Between Half Luminous Intensity Points | 3300<br>3301<br>3315<br>3316 | | 90<br>90<br>35<br>35 | | Deg. | $I_F = 10$ mA<br>See Note 1 (Figure 6) |
| | | 3400<br>3401<br>3415<br>3416 | | 90<br>90<br>35<br>35 | | Deg. | $I_F = 10$ mA<br>See Note 1 (Figure 11) |
| | | 3502<br>3507<br>3517<br>3519 | | 75°<br>75°<br>24°<br>24° | | Deg. | $I_F = 20$ mA<br>See Note 1 (Figure 16) |
| $\lambda_{PEAK}$ | Peak Wavelength | 3300<br>3400<br>3500 | | 635<br>583<br>565 | | nm | Measurement at Peak (Figure 1) |
| $\lambda_d$ | Dominant Wavelength | 3300<br>3400<br>3500 | | 626<br>585<br>569 | | nm | See Note 2 (Figure 1) |
| $\tau_s$ | Speed of Response | 3300<br>3400<br>3500 | | 90<br>90<br>500 | | ns | |
| C | Capacitance | 3300<br>3400<br>3500 | | 16<br>18<br>18 | | pF | $V_F = 0$; f = 1 MHz |
| $\theta_{JC}$ | Thermal Resistance | 3300<br>3400<br>3500 | | 140 | | °C/W | Junction to Cathode Lead at Seating Plane |
| $V_F$ | Forward Voltage | 3300<br>3400<br>3500 | 1.5<br>1.5<br>1.6 | 2.2<br>2.2<br>2.3 | 3.0<br>3.0<br>3.0 | V | $I_F = 10$ mA (Figure 2)<br>$I_F = 10$ mA (Figure 7)<br>$I_F = 20$ mA (Figure 12) |
| $V_{BR}$ | Reverse Breakdown Volt. | All | 5.0 | | | V | $I_R = 100$ μA |
| $\eta_V$ | Luminous Efficacy | 3300<br>3400<br>3500 | | 147<br>570<br>630 | | lumens Watt | See Note 3 |

NOTES:

1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

# Absolute Maximum Ratings at $T_A = 25°C$

| Parameter | 3300 Series | 3400 Series | 3500 Series | Units |
|---|---|---|---|---|
| Peak Forward Current | 90 | 60 | 90 | mA |
| Average Forward Current[1] | 25 | 20 | 25 | mA |
| DC Current[2] | 30 | 20 | 30 | mA |
| Power Dissipation[3] | 135 | 85 | 135 | mW |
| Operating and Storage Temperature Range | -55° C to +100° C | | | |
| Lead Soldering Temperature [1.6 mm (0.063 in.) from Body] | 260° C for 5 seconds | | | |

**NOTES:**

1. See Figure 5 (Red), 10 (Yellow) or 15 (Green) to establish pulsed operating conditions.
2. For Red and Green series derate linearly from 50° C at 0.5 mA/° C. For Yellow series derate linearly from 50° C at 0.2 mA/° C.
3. For Red and Green series derate power linearly from 25° C at 1.8 mW/° C. For Yellow series derate power linearly from 50° C at 1.6 mW/° C.

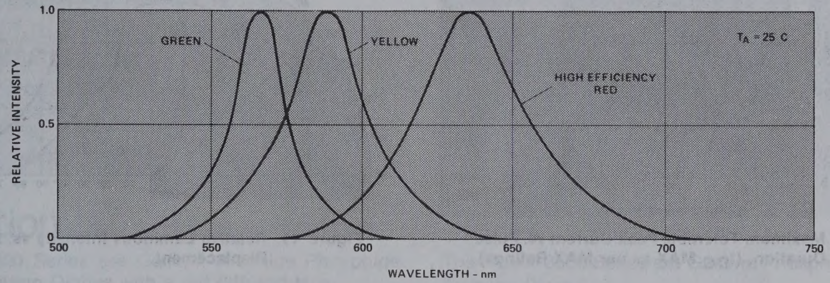


**Figure 1. Relative Intensity vs. Wavelength**

# High Efficiency Red HLMP-3300 Series

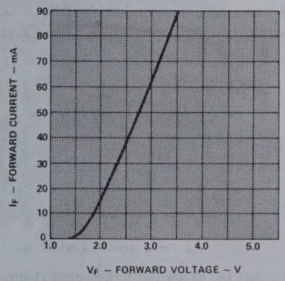


**Figure 2. Forward Current vs. Forward Voltage Characteristics.**

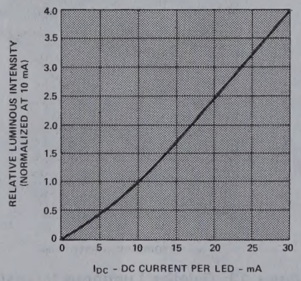


**Figure 3. Relative Luminous Intensity vs. DC Forward Current.**

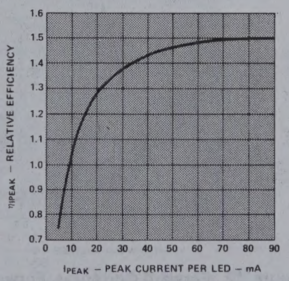


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. LED Peak Current.**

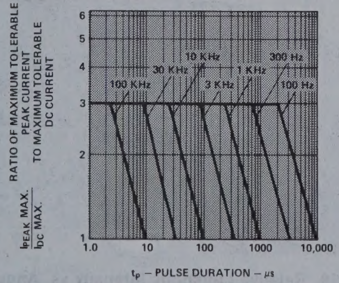


**Figure 5. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

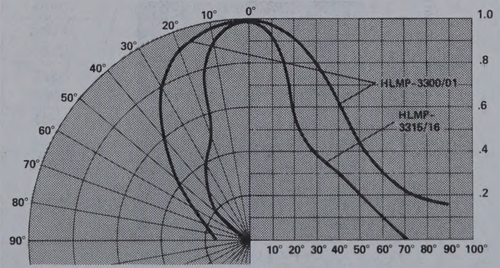


**Figure 6. Relative Luminous Intensity vs. Angular Displacement.**

# Yellow HLMP-3400 Series

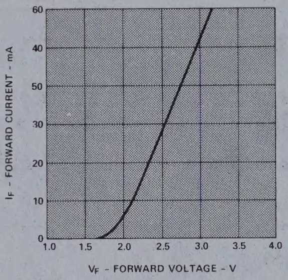


**Figure 7. Forward Current vs. Forward Voltage Characteristics.**

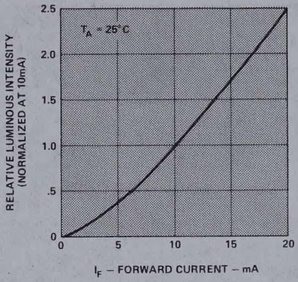


**Figure 8. Relative Luminous Intensity vs. Forward Current.**

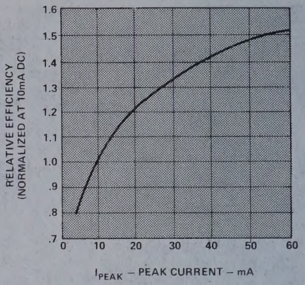


**Figure 9. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.**

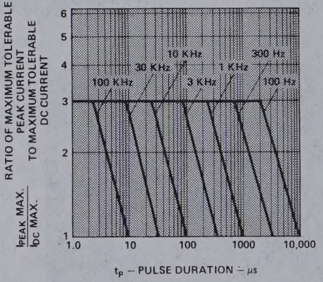


**Figure 10. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

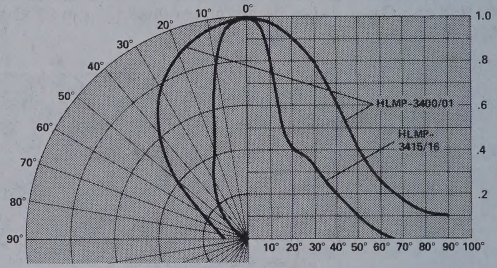


**Figure 11. Relative Luminous Intensity vs. Angular Displacement.**

# Green HLMP-3500 Series

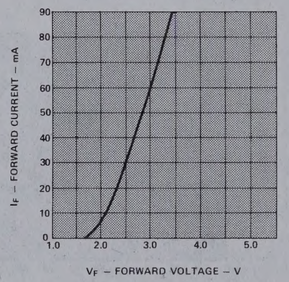


**Figure 12. Forward Current vs. Forward Voltage Characteristics.**

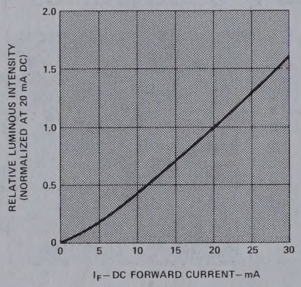


**Figure 13. Relative Luminous Intensity vs. DC Forward Current.**

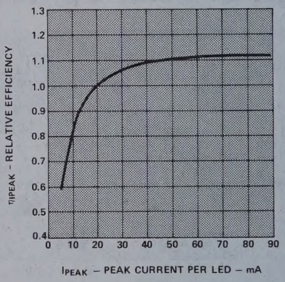


**Figure 14. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current.**

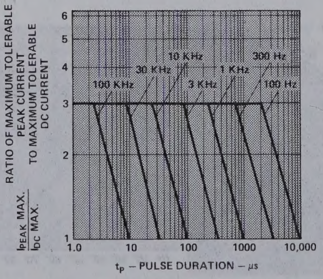


**Figure 15. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

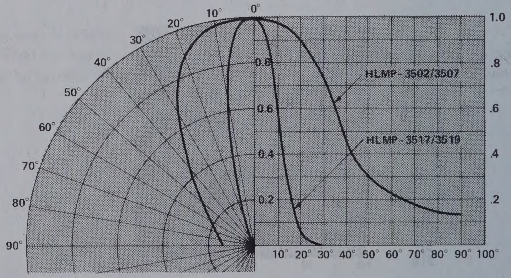


**Figure 16. Relative Luminous Intensity vs. Angular Displacement. T-1 3/4 Lamp.**

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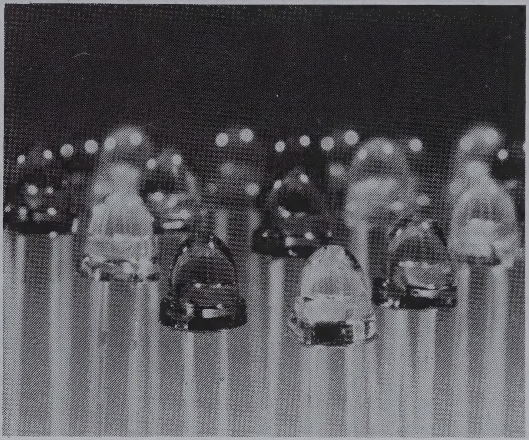
# T-1 3/4 (5mm) LOW PROFILE SOLID STATE LAMPS

RED ● HLMP-3200 SERIES (5082-4790)
HIGH EFFICIENCY RED ● HLMP-3350 SERIES (5082-4690)
YELLOW ● HLMP-3450 SERIES (5082-4590)
HIGH PERFORMANCE GREEN ● HLMP-3550 SERIES (5082-4990)

TECHNICAL DATA FEBRUARY 1982

## Features

- HIGH INTENSITY
- LOW PROFILE: 5.8mm (0.23 in) NOMINAL
- T-1¾ DIAMETER PACKAGE
- LIGHT OUTPUT CATEGORIES
- DIFFUSED AND NON-DIFFUSED TYPES
- GENERAL PURPOSE LEADS
- IC COMPATIBLE/LOW CURRENT REQUIREMENTS
- RELIABLE AND RUGGED



## Description

The HLMP-3200 Series are Gallium Arsenide Phosphide Red Light Emitting Diodes with a red diffused lens.

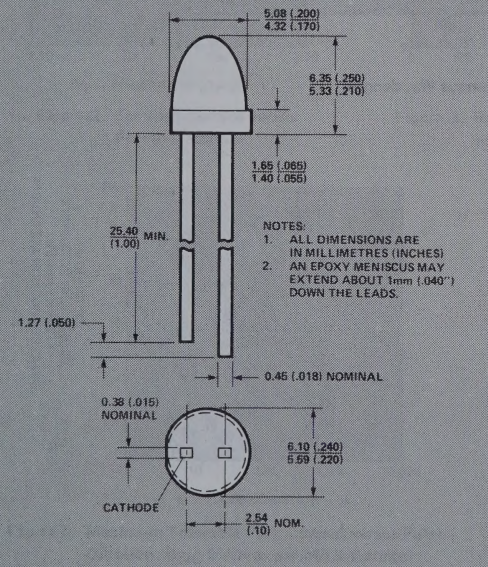
The HLMP-3350 Series are Gallium Arsenide Phosphide on Gallium Phosphide High Efficiency Red Light Emitting Diodes.

The HLMP-3450 Series are Gallium Arsenide Phosphide on Gallium Phosphide Yellow Light Emitting Diodes.

The HLMP-3550 Series are Gallium Phosphide Green Light Emitting Diodes.

The Low Profile T-1¾ package provides space savings and is excellent for backlighting applications.

## Package Dimensions



NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES)
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

| Part Number HLMP- (5082-) | Application | Lens | Color |
|---|---|---|---|
| **3200** (4790) | Indicator — General Purpose | Tinted Diffused Wide Angle | Red |
| **3201** (4791) | Indicator — High Brightness | | |
| **3350** (4690) | Indicator — General Purpose | Tinted Diffused Wide Angle | High Efficiency Red |
| **3351** (4693) | Indicator — High Brightness | | |
| **3365** (4694) | General Purpose Point Source | Tinted Non-diffused Narrow Angle | |
| **3366** (4695) | High Brightness Annunciator | | |
| **3450** (4590) | Indicator — General Purpose | Tinted Diffused Wide Angle | Yellow |
| **3451** (4592) | Indicator — High Brightness | | |
| **3465** (4595) | General Purpose Point Source | Tinted Non-diffused Narrow Angle | |
| **3466** (4597) | High Brightness Annunciator | | |
| **3553** | Indicator — General Purpose | Tinted Diffused Wide Angle | Green |
| **3554** | Indicator — High Brightness | | |
| **3567** | General Purpose Point Source | Tinted Non-diffused Narrow Angle | |
| **3568** | High Brightness Annunciator | | |

# Absolute Maximum Ratings at $T_A = 25°C$

| Parameter | 3200 Series | 3350 Series | 3450 Series | 3550 Series | Units |
|---|---|---|---|---|---|
| Peak Forward Current | 1000 | 90 | 60 | 90 | mA |
| Average Forward Current[1] | 50 | 25 | 20 | 25 | mA |
| DC Current[2] | 50 | 30 | 20 | 30 | mA |
| Power Dissipation[3] | 100 | 135 | 85 | 135 | mW |
| Operating and Storage Temperature Range | -55° C to +100° C | | | | |
| Lead Soldering Temperature [1.6 mm (0.063 in.) from Body] | 260° C for 5 seconds | | | | |

**NOTES:**

1. See Figure 5 (Red), 10 (High Efficiency Red), 15 (Yellow) or 20 (Green) to establish pulsed operating conditions.
2. For High Efficiency Red and Green Series derate linearly from 50°C at 0.5 mA/°C. For Red and Yellow Series derate linearly from 50°C at 0.2 mA/°C.
3. For High Efficiency Red and Green Series derate power linearly from 25°C at 1.8 mW/°C. For Red and Yellow Series derate power linearly from 50°C at 1.6 mW/°C.

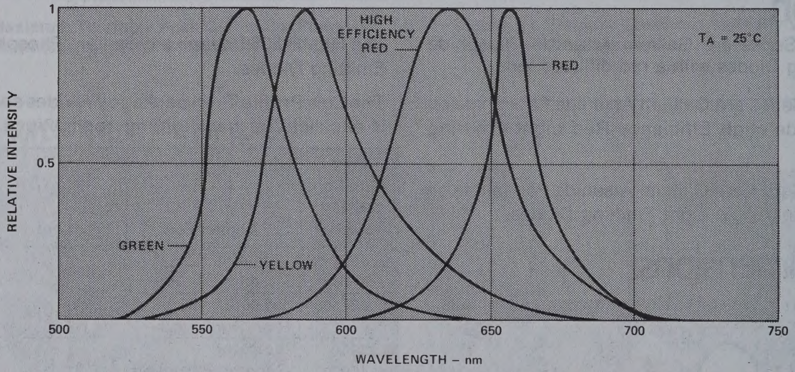


**Figure 1. Relative Intensity versus Wavelength.**

# RED HLMP-3200 SERIES

## Electrical Specifications at $T_A = 25°C$

| Symbol | Description | Device HLMP- (5082-) | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| $I_V$ | Axial Luminous Intensity | 3200 (4790) | 1.0 | 2.0 | | mcd | $I_F$ = 20mA (Fig. 3) |
| | | 3201 (4791) | 2.0 | 4.0 | | | |
| $2\theta_{1/2}$ | Included Angle Between Half Luminous Intensity Points | | | 60 | | deg. | Note 1 (Fig. 6) |
| $\lambda_{PEAK}$ | Peak Wavelength | | | 655 | | nm | Measurement @ Peak (Fig. 1) |
| $\lambda_d$ | Dominant Wavelength | | | 648 | | nm | Note 2 |
| $\tau_s$ | Speed of Response | | | 15 | | ns | |
| C | Capacitance | | | 100 | | pF | $V_F$ = 0; f = 1 MHz |
| $\theta_{JC}$ | Thermal Resistance | | | 125 | | °C/W | Junction to Cathode Lead 1.6 mm (0.063 in.) from Body |
| $V_F$ | Forward Voltage | | 1.4 | 1.6 | 2.0 | V | $I_F$ = 20mA (Fig. 2) |
| $V_{BR}$ | Reverse Breakdown Voltage | | 3 | 10 | | V | $I_R$ = 100μA |
| $\eta_V$ | Luminous Efficacy | | | 55 | | lm/W | Note 3 |

Notes: 1. $\theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity. 2. Dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device. 3. Radiant Intensity $I_e$, in watts/steradian may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

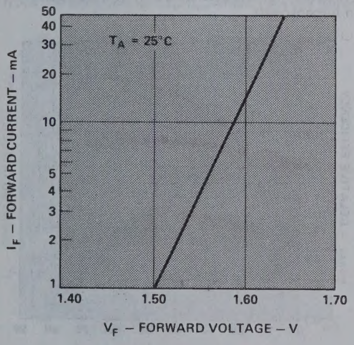


**Figure 2. Forward Current versus Forward Voltage.**

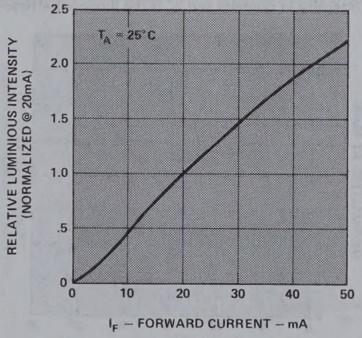


**Figure 3. Relative Luminous Intensity versus Forward Current.**

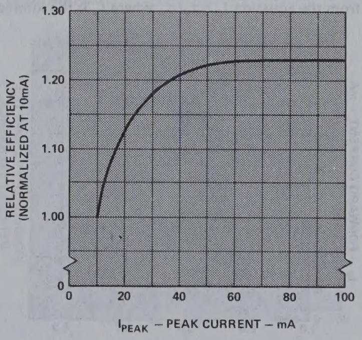


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) versus Peak Current.**

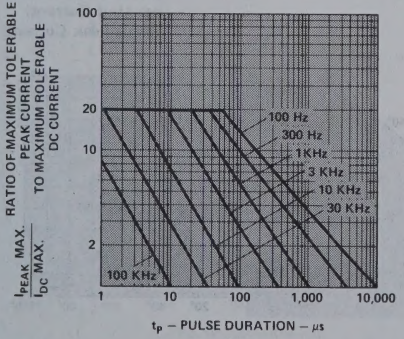


**Figure 5. Maximum Tolerable Peak Current versus Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

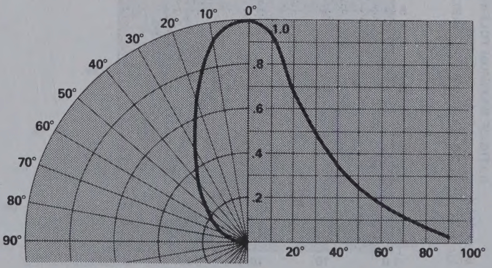


**Figure 6. Relative Luminous Intensity versus Angular Displacement.**

# HIGH EFFICIENCY RED HLMP-3350 SERIES

## Electrical Specifications at $T_A$=25°C

| Symbol | Description | Device HLMP (5082) | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| $I_V$ | Axial Luminous Intensity | 3350 (4690) | 2.0 | 3.5 |  | mcd | $I_F$ = 10mA (Fig.8) |
|  |  | 3351 (4693) | 5.0 | 7.0 |  |  |  |
|  |  | 3365 (4694) | 7.0 | 10.0 |  |  |  |
|  |  | 3366 (4695) | 12.0 | 18.0 |  |  |  |
| $2\theta_{1/2}$ | Included Angle Between Half Luminous Intensity Points | 3350 (4690) |  | 50 |  | deg. | Note 1 (Fig. 11) |
|  |  | 3351 (4693) |  | 50 |  |  |  |
|  |  | 3365 (4694) |  | 45 |  |  |  |
|  |  | 3366 (4695) |  | 45 |  |  |  |
| $\lambda_{PEAK}$ | Peak Wavelength |  |  | 635 |  | nm | Measurement @ Peak (Fig. 1) |
| $\lambda_d$ | Dominant Wavelength |  |  | 626 |  | nm | Note 2 |
| $\tau_s$ | Speed of Response |  |  | 90 |  | ns |  |
| C | Capacitance |  |  | 16 |  | pF | $V_F$ = 0; f = 1 MHz |
| $\theta_{JC}$ | Thermal Resistance |  |  | 130 |  | °C/W | Junction to Cathode Lead 1.6mm (0.063 in.) from Body |
| $V_F$ | Forward Voltage |  | 1.5 | 2.2 | 3.0 | V | $I_F$ = 10mA (Fig. 7) |
| $V_{BR}$ | Reverse Breakdown Voltage |  | 5.0 |  |  | V | $I_R$ = 100$\mu$A |
| $\eta_V$ | Luminous Efficacy |  |  | 147 |  | lm/W | Note 3 |

Notes: 1. $\theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity. 2. Dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device. 3. Radiant Intensity $I_e$, in watts/steradian may be found from the equation $I_e = I_V/\eta_V$, where $I_V$ is the luminous intensity in candelas and $\eta_V$ is the luminous efficacy in lumens/watt.

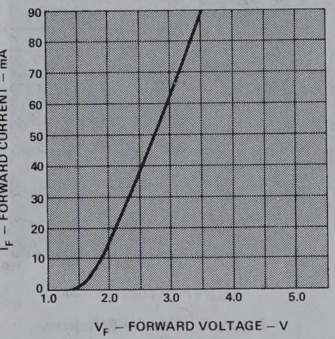


**Figure 7. Forward Current versus Forward Voltage.**

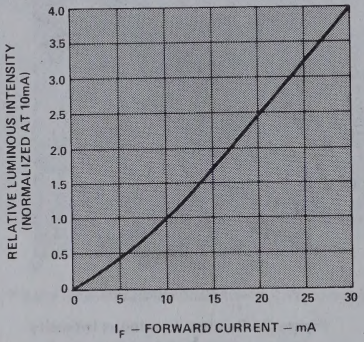


**Figure 8. Relative Luminous Intensity versus Forward Current.**

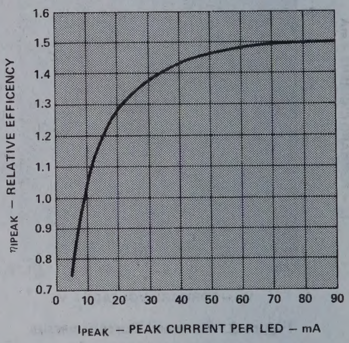


**Figure 9. Relative Efficiency (Luminous Intensity per Unit Current) versus Peak Current.**

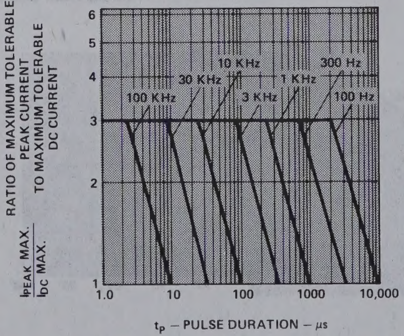


**Figure 10. Maximum Tolerable Peak Current versus Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

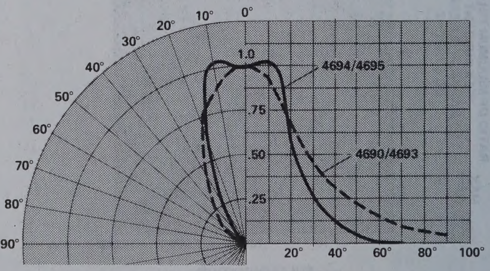


**Figure 11. Relative Luminous Intensity versus Angular Displacement.**

# YELLOW HLMP-3450 SERIES

## Electrical Specifications at $T_A$=25°C

| Symbol | Description | Device HLMP (5082) | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| $I_V$ | Axial Luminous Intensity | 3450 (4590)<br>3451 (4592)<br>3465 (4595)<br>3466 (4597) | 2.5<br>6.0<br>6.0<br>12.0 | 4.0<br>10.0<br>12.0<br>18.0 | | mcd | $I_F$ = 10mA (Fig. 13) |
| $2\theta_{1/2}$ | Included Angle Between Half Luminous Intensity Points | 3450 (4590)<br>3451 (4592)<br>3465 (4595)<br>3466 (4597) | | 50<br>50<br>45<br>45 | | deg. | Note 1 (Fig. 16) |
| $\lambda_{PEAK}$ | Peak Wavelength | | | 583 | | nm | Measurement @ Peak (Fig. 1) |
| $\lambda_d$ | Dominant Wavelength | | | 585 | | nm | Note 2 |
| $\tau_s$ | Speed of Response | | | 90 | | ns | |
| C | Capacitance | | | 18 | | pF | $V_F$ = 0; f = 1 MHz |
| $\theta_{JC}$ | Thermal Resistance | | | 100 | | °C/W | Junction to Cathode Lead 1.6mm (0.063 in.) from Body |
| $V_F$ | Forward Voltage | | 1.5 | 2.2 | 3.0 | V | $I_F$ = 10mA (Fig. 12) |
| $V_{BR}$ | Reverse Breakdown Voltage | | 5.0 | | | V | $I_R$ = 100μA |
| $\eta_V$ | Luminous Efficacy | | | 570 | | lm/W | Note 3 |

Notes: 1. $\theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity. 2. Dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device. 3. Radiant Intensity $I_e$, in watts/steradian may be found from the equation $I_e = I_V/\eta_V$, where $I_V$ is the luminous intensity in candelas and $\eta_V$ is the luminous efficacy in lumens/watt.

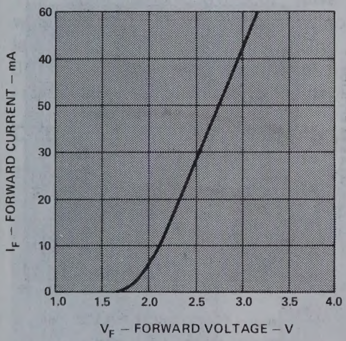


**Figure 12. Forward Current versus Forward Voltage.**

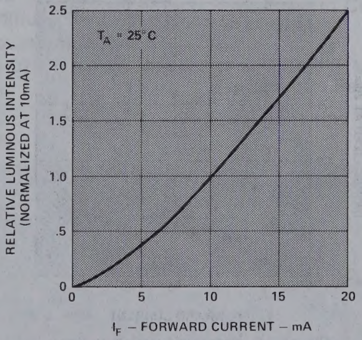


**Figure 13. Relative Luminous Intensity versus Forward Current.**

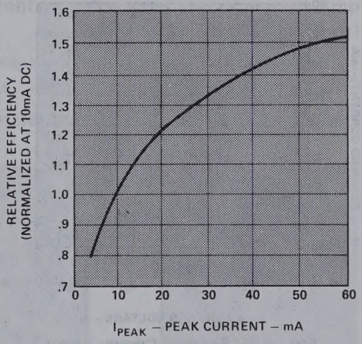


**Figure 14. Relative Efficiency (Luminous Intensity per Unit Current) versus Peak Current.**

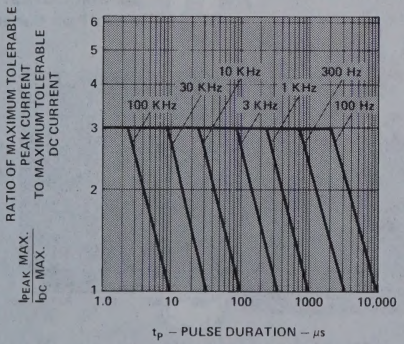


**Figure 15. Maximum Tolerable Peak Current versus Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings).**

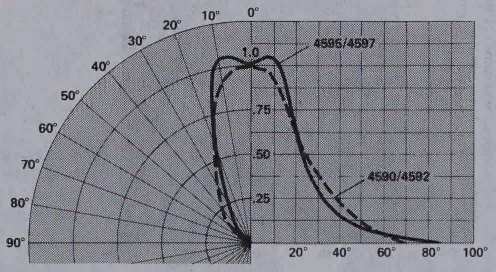


**Figure 16. Relative Luminous Intensity versus Angular Displacement**

# GREEN HLMP-3550 SERIES
# Electrical Specifications at $T_A = 25°C$

| Symbol | Description | Device HLMP- | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| Iv | Axial Luminous Intensity | 3553<br>3554<br>3567<br>3568 | 3<br>10<br>8<br>20 | 8<br>15<br>15<br>35 | | mcd | $I_F$ = 20 mA (Figure 18) |
| 2θ 1/2 | Included Angle Between Half Luminous Intensity Points | 3553<br>3554<br>3567<br>3568 | | 50<br>50<br>40<br>40 | | deg. | Note 1 (Figure 21) |
| $\lambda_{PEAK}$ | Peak Wavelength | | | 565 | | nm | Measurement @ Peak (Figure 1) |
| $\lambda_d$ | Dominant Wavelength | | | 569 | | nm | Note 2 |
| $\tau_s$ | Speed of Response | | | 500 | | ns | |
| C | Capacitance | | | 18 | | pF | $V_F$ = 0; f = 1 MHz |
| $\Theta_{JC}$ | Thermal Resistance | | | 90 | | °C/W | Junction to Cathode Lead 1.6 mm (0.063 in.) from Body |
| $V_F$ | Forward Voltage | | 1.6 | 2.3 | 3.0 | V | $I_F$ = 20 mA (Figure 17) |
| $V_{BR}$ | Reverse Breakdown Voltage | | 5.0 | | | V | $I_R$ = 100 μA |
| $\eta_v$ | Luminous Efficacy | | | 630 | | lm/W | Note 3 |

Notes: 1. $\theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity. 2. Dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device. 3. Radiant Intensity $I_e$, in watts/steradian may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

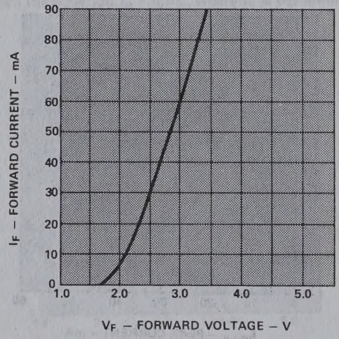


**Figure 17. Forward Current versus Forward Voltage.**

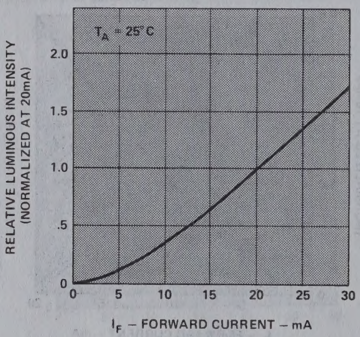


**Figure 18. Relative Luminous Intensity versus Forward Current.**

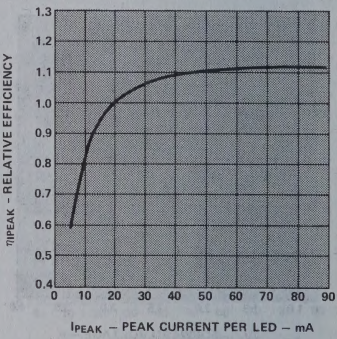


**Figure 19. Relative Efficiency (Luminous Intensity per Unit Current) versus Peak Current.**

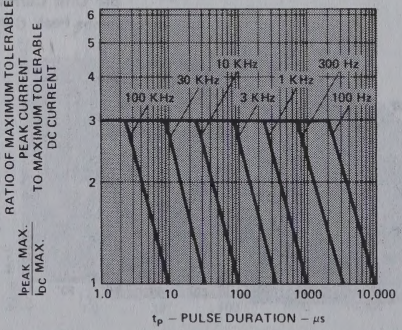


**Figure 20. Maximum Tolerable Peak Current versus Pulse Duration. ($I_{DC}$ MAX as per MAX ratings).**

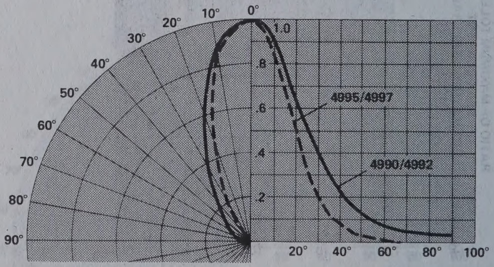


**Figure 21. Relative Luminous Intensity versus Angular Displacement.**

HEWLETT PACKARD

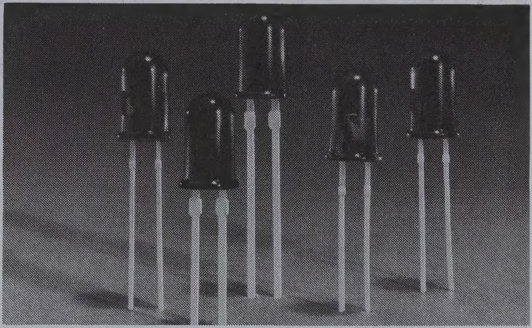
# T-1 3/4 (5mm) RED SOLID STATE LAMPS

HLMP-3000 (5082-4850)
HLMP-3001 (5082-4855)
HLMP-3002
HLMP-3050

TECHNICAL DATA FEBRUARY 1982

## Features

- **LOW COST, BROAD APPLICATIONS**
- **LONG LIFE, SOLID STATE RELIABILITY**
- **LOW POWER REQUIREMENTS: 20 mA @ 1.6V**
- **HIGH LIGHT OUTPUT:**
  **0.8 mcd Typical for HLMP-3000**
  **2.0 mcd Typical for HLMP-3001**
- **WIDE AND NARROW VIEWING ANGLE TYPES**
- **RED DIFFUSED AND NON-DIFFUSED VERSIONS**



## Description

The HLMP-3000 series lamps are Gallium Arsenide Phosphide light emitting diodes intended for High Volume/Low Cost applications such as indicators for appliances, smoke detectors, automobile instrument panels and many other commercial uses.

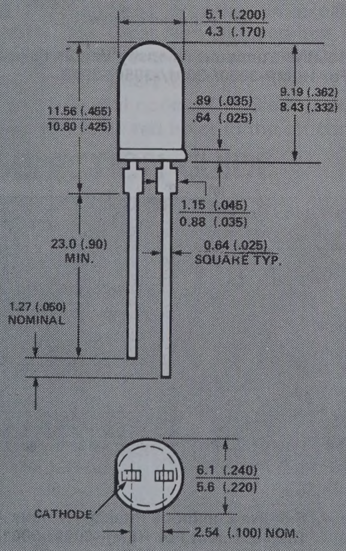
The HLMP-3000/-3001/-3002 have red diffused lenses where as the HLMP-3050 has a red non-diffused lens. These lamps can be panel mounted using mounting clip HLMP-0103. The HLMP-3000/-3001 lamps have .025" leads and the HLMP-3002/-3050 have .018" leads.

## Absolute Maximum Ratings at $T_A = 25°C$

| | |
|---|---|
| Power Dissipation | 100mW |
| DC Forward Current (Derate linearly from 50° C at 0.2 mA/° C) | 50 mA |
| Peak Forward Current | 1 Amp (1μsec pulse width, 300pps) |
| Operating and Storage Temperature Range | -55° C to +100° C |
| Lead Soldering Temperature | 230° C for 7 sec. |

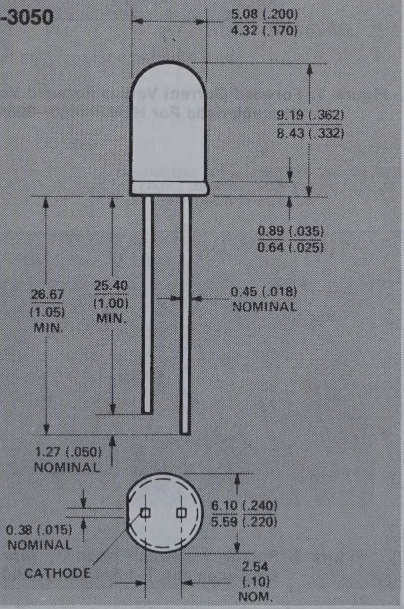
## Package Dimensions

**HLMP-3000/-3001**


5.1 (.200)
4.3 (.170)
11.56 (.455)
10.80 (.425)
.89 (.035)
.64 (.025)
9.19 (.362)
8.43 (.332)
1.15 (.045)
0.88 (.035)
23.0 (.90) MIN.
0.64 (.025) SQUARE TYP.
1.27 (.050) NOMINAL
6.1 (.240)
5.6 (.220)
CATHODE
2.54 (.100) NOM.

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

**HLMP-3002/-3050**


5.08 (.200)
4.32 (.170)
9.19 (.362)
8.43 (.332)
0.89 (.035)
0.64 (.025)
26.67 (1.05) MIN.
25.40 (1.00) MIN.
0.45 (.018) NOMINAL
1.27 (.050) NOMINAL
0.38 (.015) NOMINAL
6.10 (.240)
5.59 (.220)
CATHODE
2.54 (.10) NOM.

# Electrical Characteristics at $T_A = 25°C$

| Symbol | Parameters | HLMP-3000 | | | HLMP-3001 | | | HLMP-3002 | | | HLMP-3050 | | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| $I_V$ | Luminous Intensity | 1.0 | 2.0 | | 2.0 | 4.0 | | 0.8 | 3.0 | | 1.0 | 2.5 | | mcd | $I_F = 20mA$ |
| $\lambda_{PEAK}$ | Wavelength | | 655 | | | 655 | | | 655 | | | 655 | | nm | Measurement at Peak |
| $\tau_s$ | Speed of Response | | 10 | | | 10 | | | 10 | | | 10 | | ns | |
| C | Capacitance | | 100 | | | 100 | | | 100 | | | 100 | | pF | $V_F = 0$,<br>f = 1MHz |
| $V_F$ | Forward Voltage | 1.4 | 1.6 | 2.0 | 1.4 | 1.6 | 2.0 | 1.4 | 1.6 | 2.0 | 1.4 | 1.6 | 2.0 | V | $I_F = 20mA$ |
| $V_{BR}$ | Reverse Breakdown Voltage | 3 | 10 | | 3 | 10 | | 3 | 10 | | 3 | 10 | | V | $I_R = 100\mu A$ |
| $\theta_{JC}$ | Thermal Resistance | | 100 | | | 100 | | | 100 | | | 100 | | °C/W | Junction to Cathode Lead |
| $2\theta ½$ | Included Angle Between Half Luminous Intensity Points, Both Axes | | 90 | | | 90 | | | 90 | | | 24 | | Deg. | $I_F = 20$ mA |

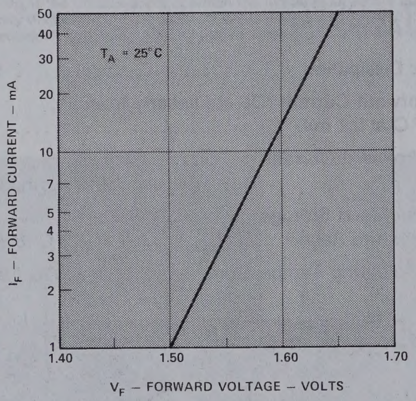


**Figure 1.** Forward Current Versus Forward Voltage Characteristic For HLMP-3000/-3001/-3050/-3002.

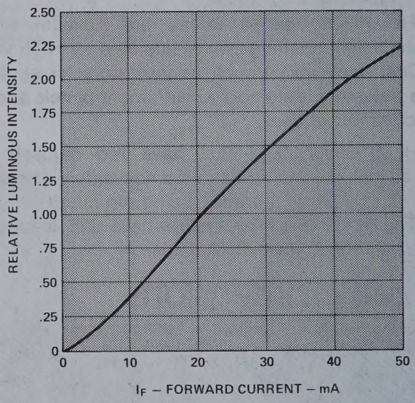


**Figure 2.** Relative Luminous Intensity Versus Forward Current For HLMP-3000/-3001/-3050/-3002.

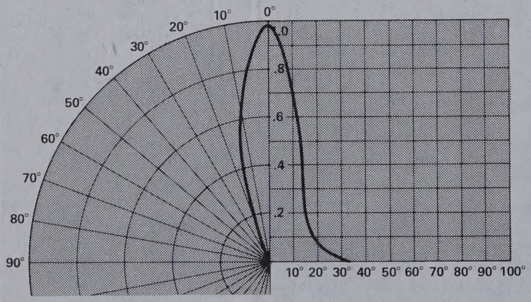


**Figure 3.** Relative Luminous Intensity Versus Angular Displacement. T-1 3/4 Lamp. HLMP-3050.

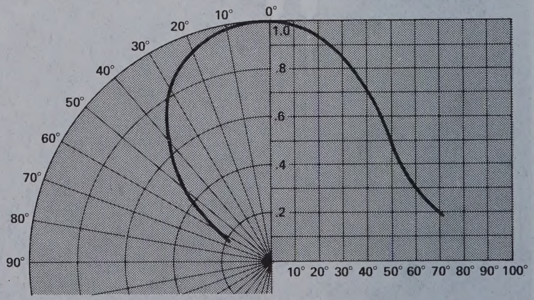


**Figure 4.** Relative Luminous Intensity Versus Angular Displacement For HLMP-3000/-3001/-3002.

HEWLETT PACKARD

# T1 3/4 (5mm) RED LED LAMPS

## HLMP-0100 (5082-4400) SERIES
## HLMP-0200 (5082-4880) SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **EASILY PANEL MOUNTABLE USING HLMP-0103 CLIP AND RING**
- **HIGH BRIGHTNESS OVER A WIDE VIEWING ANGLE**
- **RUGGED CONSTRUCTION FOR EASE OF HANDLING**
- **STURDY LEADS ON 2.54mm (0.10 in.) CENTERS**
- **IC COMPATIBLE/LOW POWER CONSUMPTION**
- **LONG LIFE**
- **METAL BASE FERRULE LAMP**

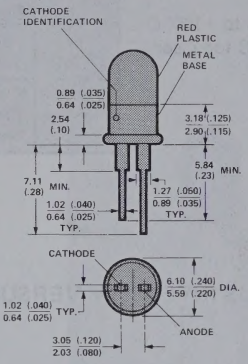

CATHODE IDENTIFICATION
RED PLASTIC
METAL BASE
0.89 (.035)
0.64 (.025)
2.54 (.10)
3.18 (.125)
2.90 (.115)
5.84 (.23) MIN.
7.11 (.28) MIN.
1.27 (.050)
0.89 (.035) TYP.
1.02 (.040)
0.64 (.025) TYP.
CATHODE
6.10 (.240)
5.59 (.220) DIA.
1.02 (.040)
0.64 (.025) TYP.
ANODE
3.05 (.120)
2.03 (.080)

**Figure A**
**HLMP-0101**
**HLMP-0102**

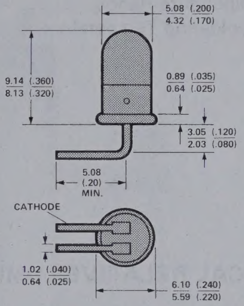

5.08 (.200)
4.32 (.170)
9.14 (.360)
8.13 (.320)
0.89 (.035)
0.64 (.025)
3.05 (.120)
2.03 (.080)
5.08 (.20) MIN.
CATHODE
1.02 (.040)
0.64 (.025)
6.10 (.240)
5.59 (.220)

**Figure B**
**HLMP-0140**
**HLMP-0141**

## Description

These LED lamps are plastic encapsulated Gallium Arsenide Phosphide Light Emitting Diodes. They radiate light in the 655 nanometer (red light) region.

The HLMP-0101 and -0102 are LEDs with a red diffused plastic lens, providing high visibility for circuit board or panel mounting with a clip.

The HLMP-0140 and -0141 have the added feature of a 90° lead bend for edge mounting on circuit boards.

The HLMP-0200 series is available in three different lens configurations. These are Red Diffused, Clear Diffused, and Clear Non-Diffused.

The Red Diffused lens provides an excellent off/on contrast ratio. The Clear Non-Diffused lens is designed for applications where a point source is desired. It is particularly useful where the light must be focused or diffused with external optics. The Clear Diffused lens is useful in masking the red color in the off condition.

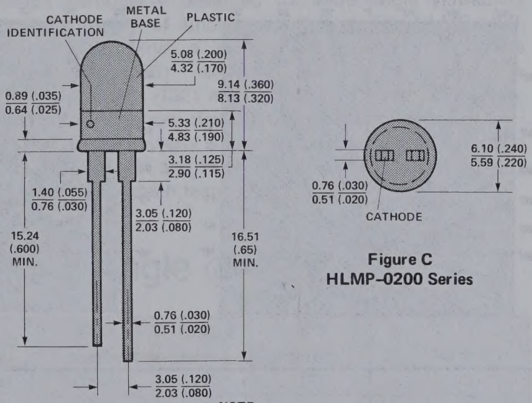

METAL BASE
PLASTIC
CATHODE IDENTIFICATION
5.08 (.200)
4.32 (.170)
9.14 (.360)
8.13 (.320)
0.89 (.035)
0.64 (.025)
5.33 (.210)
4.83 (.190)
3.18 (.125)
2.90 (.115)
1.40 (.055)
0.76 (.030)
3.05 (.120)
2.03 (.080)
15.24 (.600) MIN.
16.51 (.65) MIN.
0.76 (.030)
0.51 (.020)
3.05 (.120)
2.03 (.080)
6.10 (.240)
5.59 (.220)
0.76 (.030)
0.51 (.020)
CATHODE

**Figure C**
**HLMP-0200 Series**

NOTE:
1. DIMENSIONS IN MILLIMETRES AND (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

## LED SELECTION GUIDE

| Short Lead Ferrule Lamp Red, Diffused Lens | | Light Output (mcd) | |
|---|---|---|---|
| **Unbent Leads (Fig. A)** | **Bent Leads (Fig. B)** | **Min.** | **Typ.** |
| HLMP-0101<br>(5082-4440) | HLMP-0140<br>(5082-4444) | 0.5 | 1 |
| HLMP-0102<br>(5082-4403) | HLMP-0141<br>(5082-4415) | 1.2 | 2 |

| Long Lead Ferrule Lamp Unbent Leads (Fig. C) | | | Light Output (mcd) | |
|---|---|---|---|---|
| **Red, Diffused Lens** | **Clear Lens** | **Untinted, Diffused Lens** | **Min.** | **Typ.** |
| HLMP-0200<br>(5082-4880) | HLMP-0220<br>(5082-4883) | HLMP-0240<br>(5082-0886) | 1 | 2 |
| (HLMP-0202)<br>(5082-4882) | HLMP-0222<br>(5082-4885) | HLMP-0242<br>(5082-4888) | 2 | 3 |

# Maximum Ratings at $T_A = 25°C$

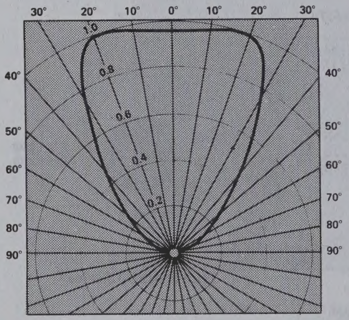
DC power Dissipation ............... 100 mW
DC Forward Current ................. 50 mA
(Derate linearly from 50° C at 0.2 mA/° C)
Peak Transient Forward Current ....... 1 Amp
(1 μsec pulse width, 300 pps)
Isolation Voltage ...................... 300V
(between lead and base)
Operating and Storage
Temperature Range ...... -55° C to +100° C
Lead Soldering Temperature . 230° C for 7 sec.

# Electrical Characteristics at $T_A = 25°C$

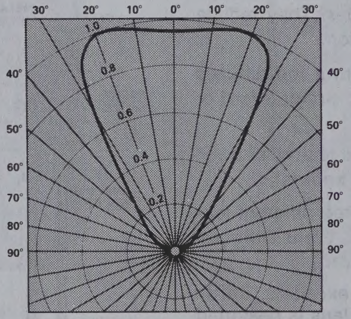
| Symbol | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $\lambda_{PEAK}$ | Wavelength | | 655 | | nm | Measurement at Peak |
| $\tau_S$ | Speed of Response | | 15 | | ns | |
| C | Capacitance | | 100 | | pF | |
| $\theta_{JC}$ | Thermal Resistance | | 87 | | °C/W | Junction to Cathode Lead |
| $V_F$ | Forward Voltage | 1.4 | 1.6 | 2.0 | V | $I_F$ = 20 mA |
| $BV_R$ | Reverse Breakdown Voltage | 3 | 10 | | V | $I_R$ = 100 μA |

## TYPICAL RELATIVE LUMINOUS INTENSITY VERSUS ANGULAR DISPLACEMENT

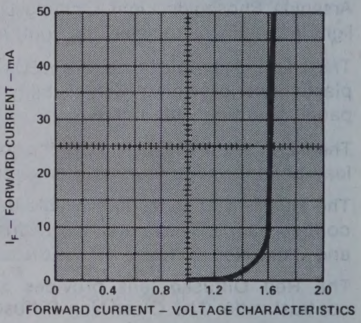
**HLMP-0100 SERIES**
**VIEWING ANGLE ($2\Theta 1/2$) = 75°**



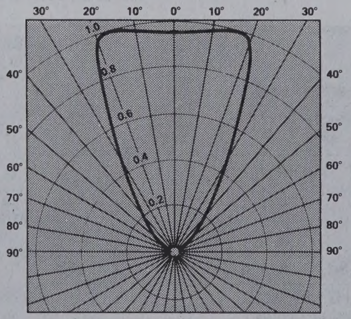
**HLMP-0200/-0202**
**HLMP-0220/-0222**
**VIEWING ANGLE ($2\Theta 1/2$) = 65°**



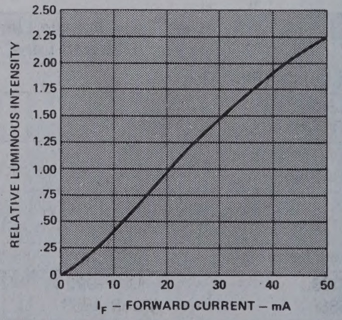
**FORWARD CURRENT VS. VOLTAGE CHARACTERISTICS**



**HLMP-0240/-0242**
**VIEWING ANGLE ($2\Theta 1/2$) = 60°**



**LUMINOUS INTENSITY VS. FORWARD CURRENT ($I_F$)**



**HEWLETT PACKARD**

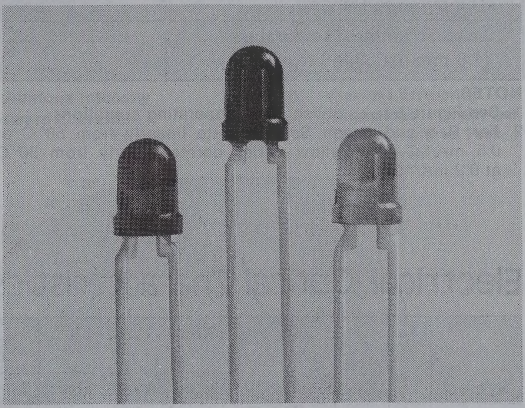
# T-1 (3mm) LED LAMPS

## High Efficiency Red HLMP-1300 Series
## Yellow HLMP-1400 Series
## High Performance Green HLMP-1500 Series

TECHNICAL DATA FEBRUARY 1982

## Features

- **IMPROVED INTENSITY**
- **CHOICE OF VIEWING ANGLE**
- **SMALL SIZE T-1 DIAMETER 3.18 mm (0.125 inch)**
- **IC COMPATIBLE**
- **RELIABLE AND RUGGED**
- **CHOICE OF 3 BRIGHT COLORS**
  - **High Efficiency Red**
  - **Yellow**
  - **High Performance Green**



## Description

These solid state lamps are available in a broad matrix of colors and finished package appearance to suit your particular application. Each device is designed to generate high axial luminous intensity and good on-off contrast.

The red and yellow devices utilize Gallium Arsenide Phosphide on Gallium Phosphide light emitting diode and the green devices utilize a Gallium Phosphide light emitting diode. The HLMP-1300, -1301, -1302 are high efficiency red lamps particularly designed for wide angle viewability under a variety of ambient conditions. The HLMP-1400, -1401, 1402 serve a similar function in yellow. The HLMP-1500, -1501, -1502 do likewise for green. The HLMP-1320 and -1321 are high efficiency red LED lamps with a more narrow viewing angle better suited for backlighting or particularly severe high ambient conditons. The HLMP-1420/1421 and HLMP-1520/1521 are similar devices in yellow and green respectively.

## Axial Luminous Intensity and Viewing Angle @ 25°C

| Part Number HLMP- | Description | $I_V$ (mcd) | | Test Condition (ma) | $-2\Theta 1/2$ (typ.) (1) | $\lambda D$ (nm-typ.) (2) | Color |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | | | | |
| 1300 | Tinted, Diffused | 1.0 | 2.0 | 10 | 60° | 626 | High Efficiency Red |
| 1301 | Tinted, Diffused | 2.0 | 2.5 | | 60° | | |
| 1302 | Tinted, Diffused | 3.0 | 4.0 | | 60° | | |
| 1320 | Untinted, Non-Diffused | 2.0 | 4.0 | | 45° | | |
| 1321 | Tinted, Non-Diffused | 2.0 | 4.0 | | 45° | | |
| 1400 | Tinted, Diffused | 1.0 | 2.0 | 10 | 60° | 585 | Yellow |
| 1401 | Tinted, Diffused | 2.0 | 3.0 | | 60° | | |
| 1402 | Tinted, Diffused | 3.0 | 4.0 | | 60° | | |
| 1420 | Untinted, Non-Diffused | 2.0 | 4.0 | | 45° | | |
| 1421 | Tinted, Non-Diffused | 2.0 | 4.0 | | 45° | | |
| 1503 | Tinted, Diffused | 2.0 | 5.0 | 20 | 60° | 569 | Green |
| 1523 | Tinted, Diffused | 5.0 | 10.0 | | 60° | | |
| 1520 | Untinted, Non-Diffused | 2.0 | 4.0 | | 45° | | |
| 1521 | Tinted, Non-Diffused | 2.0 | 4.0 | | 45° | | |

**NOTES:**
1. $\Theta 1/2$ is the off-axis angle at which the luminous intensity is half the axial intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.

# Absolute Maximum Ratings at $T_A$ = 25°C

| Parameter | Red | Yellow | Green | Units |
|---|---|---|---|---|
| Peak Forward Current | 90 | 60 | 90 | mA |
| Average Forward Current[1] | 25 | 20 | 25 | mA |
| DC Current[2] | 30 | 20 | 30 | mA |
| Power Dissipation[3] | 135 | 85 | 135 | mW |
| Operating and Storage Temperature Range | -55° C to +100° C | | | |
| Lead Soldering Temperature [1.6 mm (0.063 in.) from Body] | 260° C for 5 seconds | | | |

**NOTES:**

1. See Figure 5 to establish pulsed operating conditions.
2. For Red and Green Series derate linearly from 50° C at 0.5 mA/° C. For Yellow Series derate linearly from 50° C at 0.2 mA/° C.
3. For Red and Green series derate power linearly from 25° C at 1.8 mW/° C. For Yellow series derate power linearly from 50° C at 1.6 mW/° C.

# Electrical/Optical Characteristics at $T_A$ = 25°C

| Symbol | Description | HLMP-1300, -1301, -1302 | | | HLMP-1400, -1401, -1402 | | | HLMP-1503,-1523 | | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| $\lambda_{peak}$ | Peak Wavelength | | 635 | | | 583 | | | 565 | | nm | Measurement at Peak, Fig. 1 |
| $\tau_s$ | Speed of Response | | 90 | | | 90 | | | 500 | | ns | |
| C | Capacitance | | 20 | | | 15 | | | 18 | | pF | $V_F$=0; f=1 MHz |
| $\Theta_{JC}$ | Thermal Resistance | | 95 | | | 95 | | | 95 | | °C/W | Junction to Cathode Lead at 0.79mm (0.031 in.) From Body |
| $V_F$ | Forward Voltage | 1.5 | 2.2 | 3.0 | 1.5 | 2.2 | 3.0 | 1.6 | 2.3<br>at $I_F$ = 20mA | 3.0 | V | $I_F$=10mA (Figs. 2,7,12) |
| $BV_R$ | Reverse Breakdown Voltage | 5.0 | | | 5.0 | | | 5.0 | | | V | $I_R$=100$\mu$A |
| $\eta_v$ | Luminous Efficacy | | 147 | | | 570 | | | 630 | | 1m/W | Note 1 |

**NOTES:**

1. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e=I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

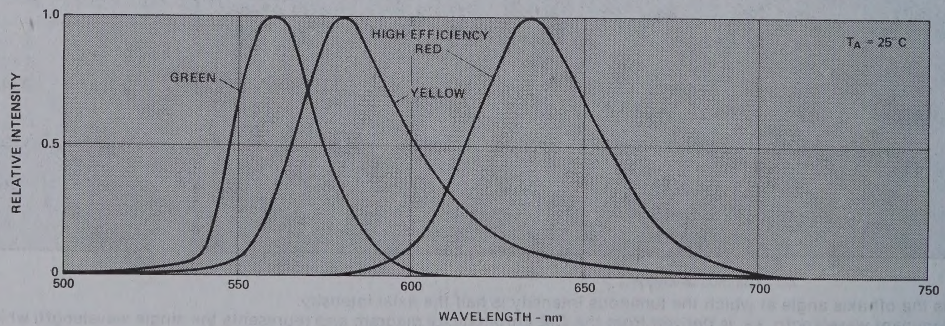


Figure 1. Relative Intensity vs. Wavelength.

# High Efficiency Red HLMP-1300,-1301,-1302

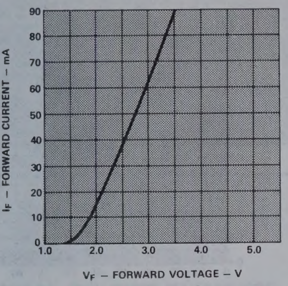


**Figure 2.** Forward Current vs. Forward Voltage Characteristics.

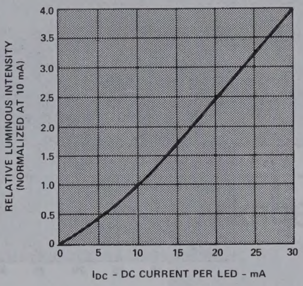


**Figure 3.** Relative Luminous Intensity vs. DC Forward Current.

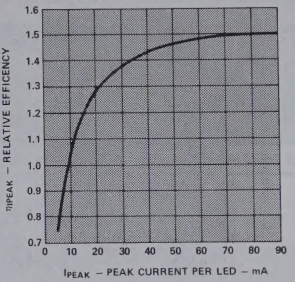


**Figure 4.** Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current.

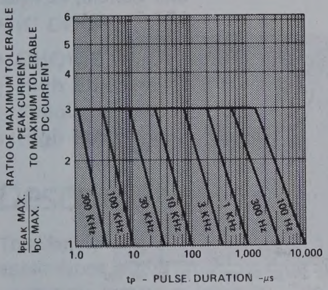


**Figure 5.** Maximum Tolerable Peak Current vs. Pulse Duration. (IDCMAX as per MAX Ratings).

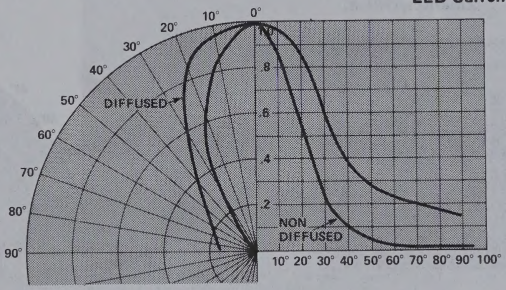


**Figure 6.** Relative Luminous Intensity vs. Angular Displacement.

# Yellow HLMP-1400,-1401,-1402

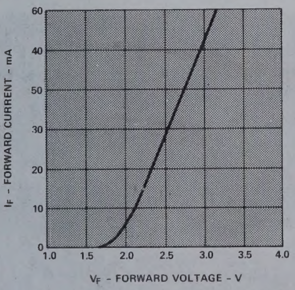


**Figure 7.** Forward Current vs. Forward Voltage Characteristics.

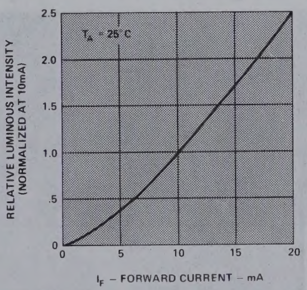


**Figure 8.** Relative Luminous Intensity vs. Forward Current.

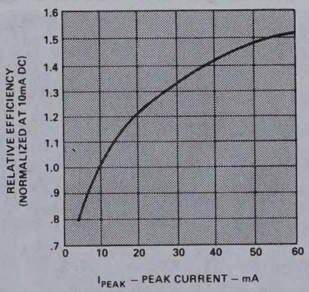


**Figure 9.** Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

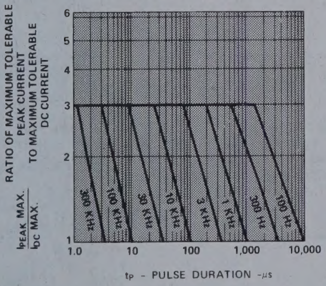


**Figure 10.** Maximum Tolerable Peak Current vs. Pulse Duration. (IDC MAX as per MAX Ratings.)

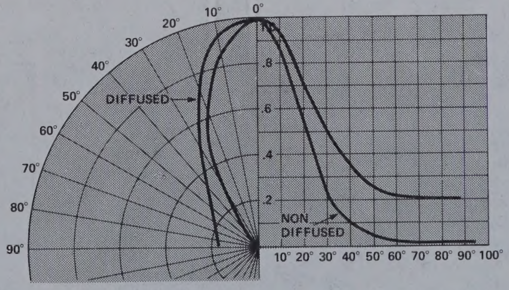


**Figure 11.** Relative Luminous Intensity vs. Angular Displacement.

# Green HLMP-1500,-1501,-1502

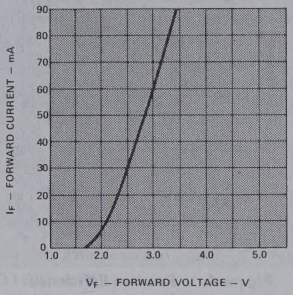


**Figure 12.** Forward Current vs. Forward Voltage Characteristics.

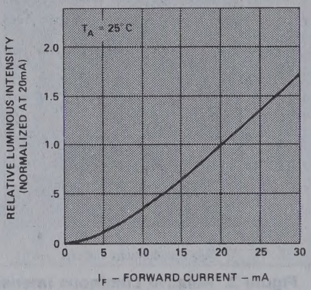


**Figure 13.** Relative Luminous Intensity vs. Forward Current.

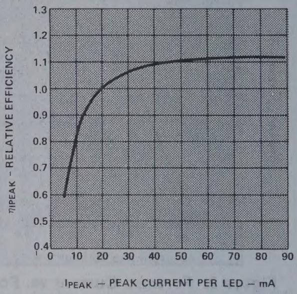


**Figure 14.** Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current.

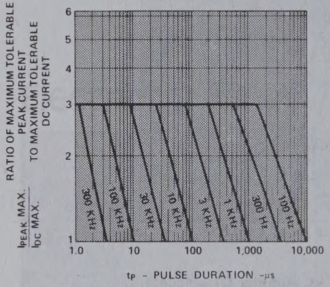


**Figure 15.** Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings.)

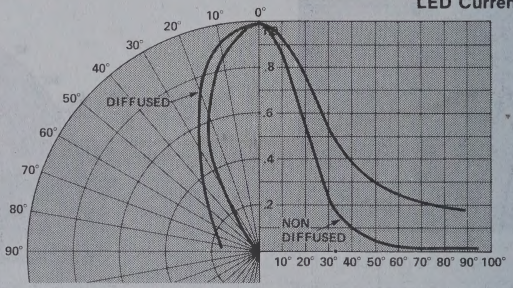
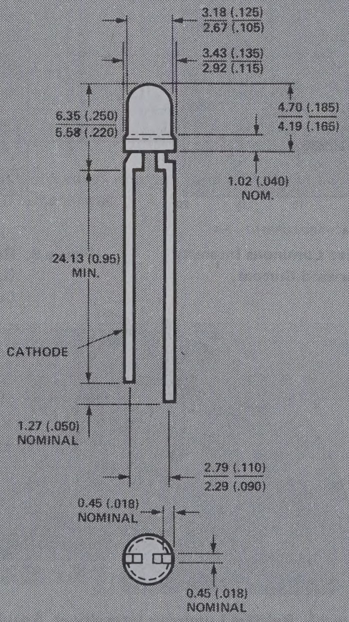


**Figure 16.** Relative Luminous Intensity vs. Angular Displacement.

## Package Dimensions



3.18 (.125)
2.67 (.105)
3.43 (.135)
2.92 (.115)
6.35 (.250)
5.58 (.220)
4.70 (.185)
4.19 (.165)
1.02 (.040) NOM.
24.13 (0.95) MIN.
CATHODE
1.27 (.050) NOMINAL
2.79 (.110)
2.29 (.090)
0.45 (.018) NOMINAL
0.45 (.018) NOMINAL

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

HEWLETT PACKARD

# LOW PROFILE T-1 (3mm) LED LAMPS

High Efficiency Red HLMP-1350
Yellow HLMP-1450
High Performance Green HLMP-1550

TECHNICAL DATA FEBRUARY 1982

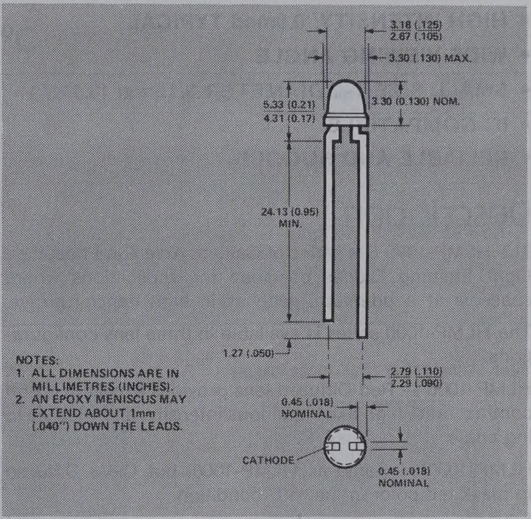
## Features

- **LOW PROFILE HEIGHT**
- **SMALL T-1 SIZE DIAMETER 3.18 mm (.125 inch)**
- **HIGH INTENSITY**
- **IC COMPATIBLE**
- **CHOICE OF 3 BRIGHT COLORS**
  **High Efficiency Red**
  **Yellow**
  **High Performance Green**

## Description

This family of solid state lamps is especially suited for applications where small package size is required without sacrificing luminous intensity. The HLMP-1350 is a red tinted, diffused lamp providing a wide viewing angle. The HLMP-1450 and HLMP-1550 are similar products in yellow and green respectively.

## Package Dimensions



NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

## Axial Luminous Intensity and Viewing Angle @ 25°C

| Part Number HLMP- | Description | Iv (mcd) | | Test Condition (ma) | 2Θ1/2 (typ.) (1) | λd (nm-typ.) (2) | Color |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | | | | |
| 1350 | Tinted, Wide Angle | 1.0 | 2.0 | 10 | 54° | 626 | High Efficiency Red |
| 1450 | Tinted, Wide Angle | 1.0 | 2.0 | 10 | 54° | 585 | Yellow |
| 1550 | Tinted, Wide Angle | 1.0 | 2.0 | 20 | 54° | 569 | Green |

**NOTES:**
1. Θ1/2 is the off-axis angle at which the luminous intensity is half the axial intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.

**For Maximum Ratings and Electrical/Optical Characteristics (including figures) see page 207 except for Figure A shown here.**

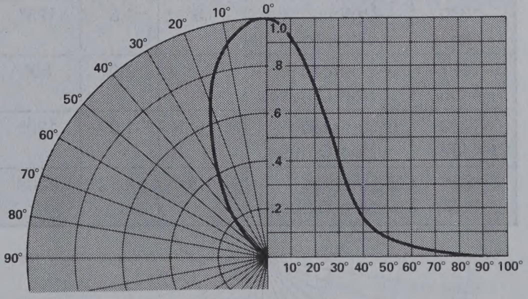


**Figure A. Relative Luminous Intensity vs. Angular Displacement.**

HEWLETT PACKARD

# T-1 (3mm) RED LED LAMPS

## HLMP-1000 Series
## HLMP-1200 Series
## (5082-4494/-4480 Series)

TECHNICAL DATA FEBRUARY 1982

## Features

- **HIGH INTENSITY: 0.8mcd TYPICAL**
- **WIDE VIEWING ANGLE**
- **SMALL SIZE T-1 DIAMETER 3.18mm (0.125")**
- **IC COMPATIBLE**
- **RELIABLE AND RUGGED**

## Description

The HLMP-1000 is a series of Gallium Arsenide Phosphide Light Emitting Diodes designed for applications where space is at a premium, such as in high density arrays.

The HLMP-1000 series is available in three lens configurations.

HLMP-1000 — Red Diffused lens provides excellent on-off contrast ratio, high axial luminous intensity, and wide viewing angle.

HLMP-1080 — Same as HLMP-1000, but Clear Diffused to mask red color in the "off" condition.

HLMP-1071/-1201 — Clear Non-Diffused plastic lens provides a point source. Useful when illuminating external lens, annunciators, or photo-detectors.

| Part Number HLMP- (5082-) | Package & Lens Type | Iv (mcd) @ 20 mA | | Viewing Angle 2Θ 1/2 |
|---|---|---|---|---|
| | | Min. | Typ. | |
| -1000 (-4480) | A-Red Diffused | .5 | 1.0 | 125° |
| -1002 (-4494) | A-Red Diffused | 1.5 | 2.5 | 125° |
| -1080 (-4483) | A-Untinted Diffused | .5 | 1.5 | 125° |
| -1071 (-4486) | A-Untinted Non Diffused | 1.0 | 2.0 | 80° |
| -1200 (-4487) | B-Untinted Non Diffused | .5 | 1.0 | 120° |
| -1201 (-4488) | B-Untinted Non Diffused | 1.5 | 2.5 | 120° |

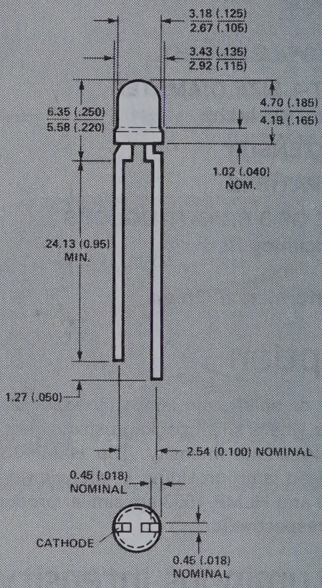

3.18 (.125)
2.67 (.105)
3.43 (.135)
2.92 (.115)
6.35 (.250)
5.58 (.220)
4.70 (.185)
4.19 (.165)
1.02 (.040)
NOM.
24.13 (0.95)
MIN.
1.27 (.050)
2.54 (0.100) NOMINAL
0.45 (.018)
NOMINAL
CATHODE
0.45 (.018)
NOMINAL

Figure A.

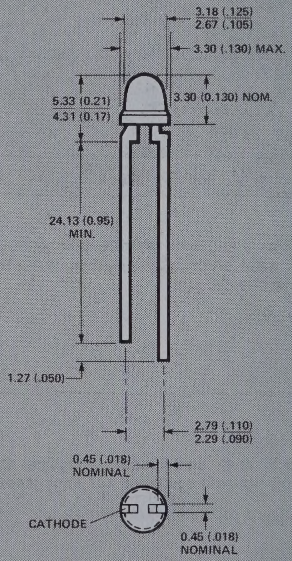

3.18 (.125)
2.67 (.105)
3.30 (.130) MAX.
5.33 (0.21)
4.31 (0.17)
3.30 (0.130) NOM.
24.13 (0.95)
MIN.
1.27 (.050)
2.79 (.110)
2.29 (.090)
0.45 (.018)
NOMINAL
CATHODE
0.45 (.018)
NOMINAL

Figure B.

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

# Maximum Ratings at $T_A = 25°C$

DC Power Dissipation .................. 100mW

DC Forward Current .................. 50mA
(Derate linearly from 50°C at 0.2mA/°C)

Peak Forward Current .................. 1 Amp
(1 μsec pulse width, 300 pps)

Operating and Storage
Temperature Range ............ –55°C to +100°C

Lead Soldering Temperature ....... 260°C for 5 sec.

# Electrical Characteristics at $T_A = 25°C$

| Symbol | Parameters | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $\lambda_{PEAK}$ | Wavelength | | 655 | | nm | |
| $\tau_s$ | Speed of Response | | 15 | | ns | |
| C | Capacitance | | 100 | | pF | $V_F = 0$, f = 1MHz |
| $\theta_{JC}$ | Thermal Resistance | | 270 | | °C/W | Junction to Cathode Lead |
| $V_F$ | Forward Voltage | 1.4 | 1.6 | 2.0 | V | $I_F = 20mA$ |
| $V_{BR}$ | Reverse Breakdown Voltage | 3 | 10 | | V | $I_R = 100 \mu A$ |

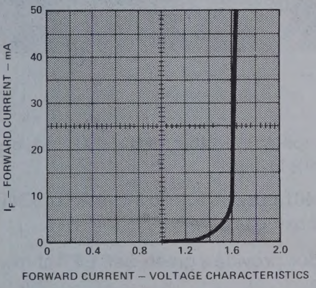


**Figure 1. Forward Current vs. Voltage Characteristic.**

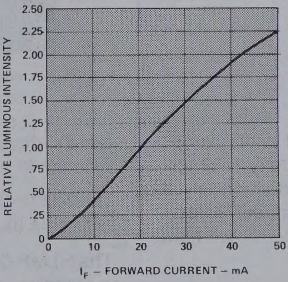


**Figure 2. Luminous Intensity vs. Forward Current (IF).**

HLMP-1200/-1201 (5082-4487/-4488)

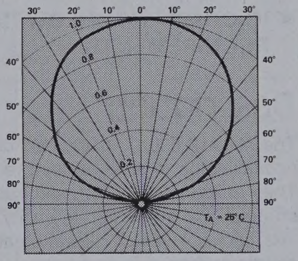


**Figure 3. Typical Relative Luminous Intensity vs. Angular Displacement.**

HLMP-1000/-1002/-1080 (5082-4480/-4494/-4483)

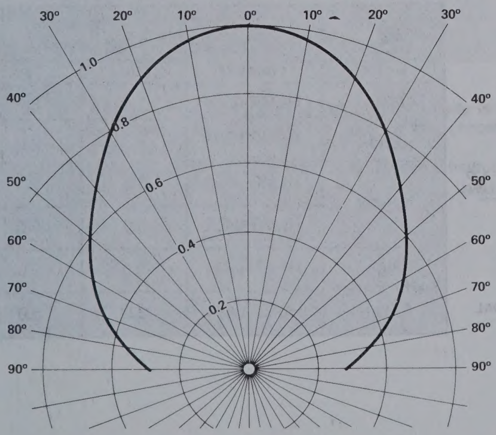


**Figure 4. Relative Luminous Intensity vs. Angular Displacement.**

HLMP-1071 (5082-4486)

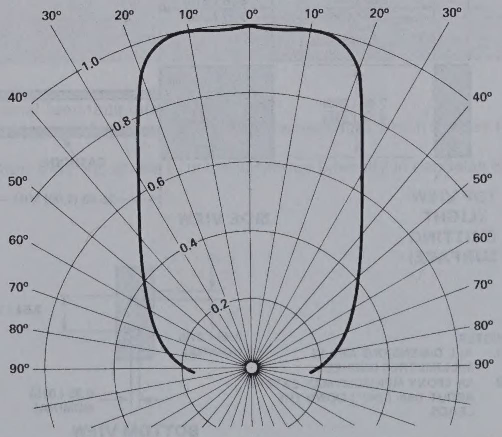


**Figure 5. Relative Luminous Intensity vs. Angular Displacement.**

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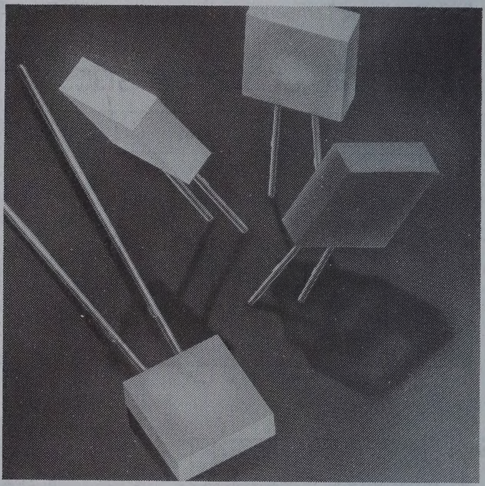
# RECTANGULAR SOLID STATE LAMPS

## HIGH EFFICIENCY RED HLMP-0300/0301
## YELLOW HLMP-0400/0401
## HIGH PERFORMANCE GREEN HLMP-0503/0504

TECHNICAL DATA FEBRUARY 1982

## Features

- **RECTANGULAR LIGHT EMITTING SURFACE**
- **FLAT HIGH STERANCE EMITTING SURFACE**
- **STACKABLE ON 2.54 MM (0.100 INCH) CENTERS**
- **IDEAL AS FLUSH MOUNTED PANEL INDICATORS**
- **IDEAL FOR BACKLIGHTING LEGENDS**
- **LONG LIFE: SOLID STATE RELIABILITY**
- **CHOICE OF 3 BRIGHT COLORS**
  - **HIGH EFFICIENCY RED**
  - **YELLOW**
  - **HIGH PERFORMANCE GREEN**
- **IC COMPATIBLE/LOW CURRENT REQUIREMENTS**



## Description

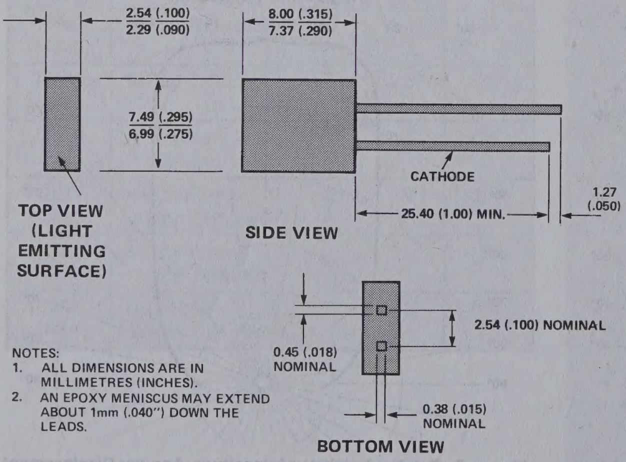
The HLMP-030X, -040X, -050X are solid state lamps encapsulated in an axial lead rectangular epoxy package. They utilize a tinted, diffused epoxy to provide high on-off contrast and a flat high intensity emitting surface. Borderless package design allows creation of uninterrupted light emitting areas.

The HLMP-0300 and -0301 have a high efficiency red GaAsP on GaP LED chip in a light red epoxy package. This lamp's efficiency is comparable to that of the GaP red, but extends to higher current levels.

The HLMP-0400 and -0401 provide a yellow GaAsP on GaP LED chip in a yellow epoxy package.

The HLMP-0503 and -0504 provide a green GaP LED chip in a green epoxy package.

## Package Dimensions


2.54 (.100)
2.29 (.090)
8.00 (.315)
7.37 (.290)
7.49 (.295)
6.99 (.275)
CATHODE
1.27 (.050)
25.40 (1.00) MIN.
TOP VIEW (LIGHT EMITTING SURFACE)
SIDE VIEW
0.45 (.018) NOMINAL
2.54 (.100) NOMINAL
0.38 (.015) NOMINAL
BOTTOM VIEW

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

## Axial Luminous Intensity

| Color | Part Number | $I_V$ (mcd) @ 20 mA DC | |
|---|---|---|---|
| | | Min. | Typ. |
| High Efficiency Red | HLMP-0300 | 1.0 | 2.5 |
| | HLMP-0301 | 2.5 | 5.0 |
| Yellow | HLMP-0400 | 1.5 | 2.5 |
| | HLMP-0401 | 3.0 | 5.0 |
| High Performance Green | HLMP-0503 | 1.5 | 2.5 |
| | HLMP-0504 | 3.0 | 5.0 |

## Absolute Maximum Ratings at $T_A = 25°C$

| Parameter | HLMP-0300/-0301 | HLMP-0400/-0401 | HLMP-0503/-0504 | Units |
|---|---|---|---|---|
| Peak Forward Current | 90 | 60 | 90 | mA |
| Average Forward Current[1] | 25 | 20 | 25 | mA |
| DC Current[2] | 30 | 20 | 30 | mA |
| Power Dissipation[3] | 135 | 85 | 135 | mW |
| Operating and Storage Temperature Range | -55° C to +100° C | | | |
| Lead Soldering Temperature [1.6 mm (0.063 in.) from Body] | 260° C for 5 seconds | | | |

**NOTES:**

1. See Figure 5 to establish pulsed operating conditions.
2. For Red and Green Series derate linearly from 50° C at 0.5 mA/° C. For Yellow Series derate linearly from 50° C at 0.2 mA/° C.
3. For Red and Green series derate power linearly from 25° C at 1.8 mW/° C. For Yellow series derate power linearly from 50° C at 1.6 mW/° C.

## Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Description | HLMP-0300/0301 | | | HLMP-0400/0401 | | | HLMP-0503/0504 | | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| $2\Theta_{1/2}$ | Included Angle Between Half Luminous Intensity Points, Both Axes | | 100 | | | 100 | | | 100 | | deg. | Note 1. Figure 6. |
| $\lambda_{PEAK}$ | Peak Wavelength | | 635 | | | 583 | | | 565 | | nm | Measurement at Peak |
| $\lambda_d$ | Dominant Wavelength | | 626 | | | 585 | | | 569 | | nm | Note 2 |
| $\tau_S$ | Speed of Response | | 90 | | | 90 | | | 500 | | ns | |
| C | Capacitance | | 17 | | | 17 | | | 18 | | pF | $V_F$=0; f=1 MHz |
| $\Theta_{JC}$ | Thermal Resistance | | 140 | | | 140 | | | 140 | | ° C/W | Junction to Cathode Lead at 1.6 mm (0.063 in.) from Body |
| $V_F$ | Forward Voltage | 1.6 | 2.5 | 3.0 | 1.6 | 2.5 | 3.0 | 1.6 | 2.3 | 3.0 | V | $I_F$= 20mA<br>Figure 2. |
| $V_{BR}$ | Reverse Breakdown Voltage | 5.0 | | | 5.0 | | | 5.0 | | | V | $I_R = 100\ \mu A$ |
| $\eta_v$ | Luminous Efficacy | | 147 | | | 570 | | | 630 | | lm/W | Note 3 |

NOTES:

1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_V/\eta_V$, where $I_V$ is the luminous intensity in candelas and $\eta_V$ is the luminous efficacy in lumens/watt.

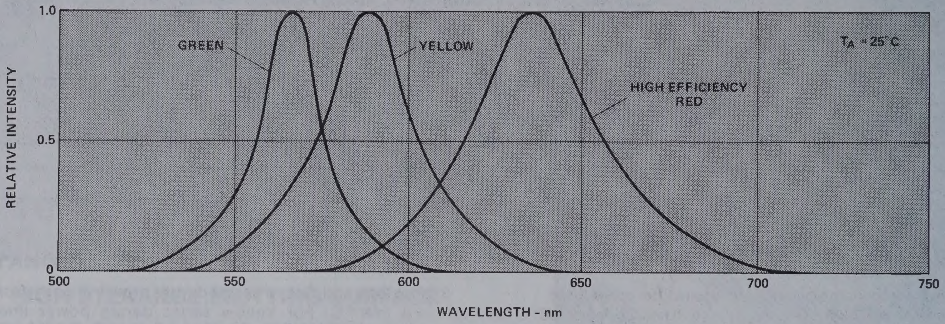


**Figure 1. Relative Intensity vs. Wavelength.**

# High Efficiency Red, Yellow and Green Rectangular Lamps

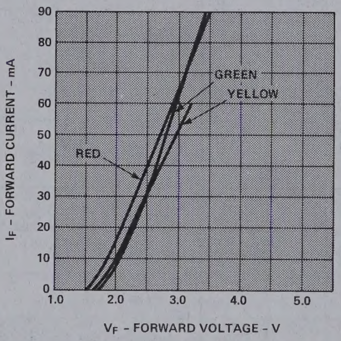


**Figure 2. Forward Current vs. Forward Voltage.**

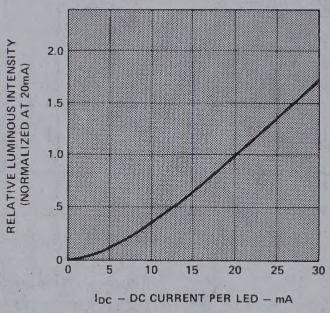


**Figure 3. Relative Luminous Intensity vs. Forward Current.**

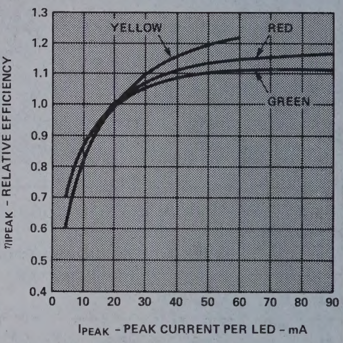


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.**

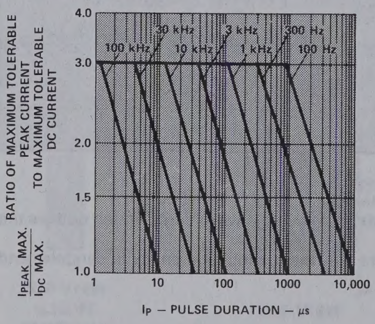


**Figure 5. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings.)**

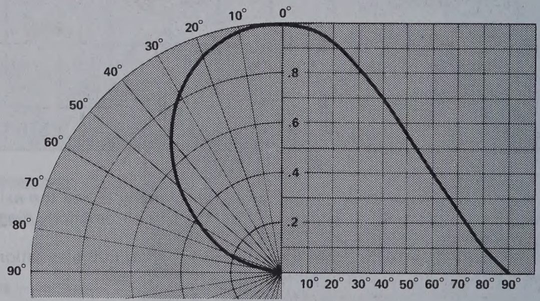


**Figure 6. Relative Luminous Intensity vs. Angular Displacement.**

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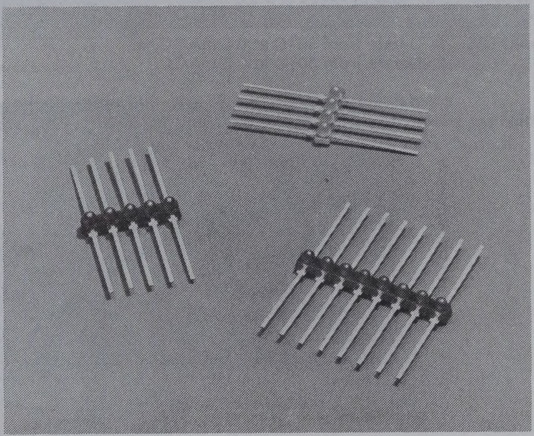
# MATCHED ARRAYS OF SUBMINIATURE LAMPS

RED HLMP-6200 SERIES
HIGH EFFICIENCY RED HLMP-6650 SERIES
YELLOW HLMP-6750 SERIES
GREEN HLMP-6850 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **IMPROVED BRIGHTNESS**
- **AVAILABLE IN 4 BRIGHT COLORS**
  - **Red**
  - **High Efficiency Red**
  - **Yellow**
  - **High Performance Green**
- **EXCELLENT UNIFORMITY BETWEEN ELEMENTS**
- **END STACKABLE FOR LONGER ARRAYS**
- **SELECTION OF VARIOUS LENGTHS**
- **COMPACT SUBMINIATURE PACKAGE STYLE**
- **NO CROSSTALK BETWEEN ELEMENTS**



## Description

The HLMP-6XXX Series Arrays are comprised of several subminiature lamps molded as a single bar. Arrays are tested to assure 2.1 to 1 matching between elements and intensity binned for matching between arrays.

The HLMP-620X Series Arrays are Gallium Arsenide Phosphide red light emitting diodes. The HLMP-665X, HLMP-675X series arrays are Gallium Arsenide Phosphide on Gallium Phosphide red and yellow light emitting diodes. The HLMP-685X series arrays are Gallium Phosphide green light emitting diodes.

Each element has separately accessible leads and a diffused lens which provides a wide viewing angle and a high on/off contrast ratio. The center-to-center spacing is 2.54 mm (.100 in.) between elements. Special lead bending is available on 2.54 mm (.100 in.) and 5.08 mm (.200 in.) centers.

| Array Length | Red | High Efficiency Red | Yellow | High Performance Green |
|---|---|---|---|---|
| 3-Element HLMP- | 6203 | 6653 | 6753 | 6853 |
| 4-Element HLMP- | 6204 | 6654 | 6754 | 6854 |
| 5-Element HLMP- | 6205 | 6655 | 6755 | 6855 |
| 6-Element HLMP- | 6206 | 6656 | 6756 | 6856 |
| 8-Element HLMP- | 6208 | 6658 | 6758 | 6858 |

## Applications

- **INDUSTRIAL CONTROLS**
- **POSITION INDICATORS**
- **OFFICE EQUIPMENT**
- **INSTRUMENTATION LOGIC INDICATORS**
- **CONSUMER PRODUCTS**

## Axial Luminous Intensity and Viewing Angle at 25°C

| Part Number | Number of Elements | Color | $I_V$ per Element (mcd) @ 10 mA DC | | $2\Theta 1/2$ Note 1. |
|---|---|---|---|---|---|
| | | | Min. | Typ. | |
| HLMP-620X | X = 3,4, 5,6,8 | Red | .5 | 1.2 | 45° |
| HLMP-665X | X = 3,4 5,6,8 | High Efficiency Red | 1.0 | 3.0 | 80° |
| HLMP-675X | X = 3,4 5,6,8 | Yellow | 1.0 | 3.0 | 90° |
| HLMP-685X | X = 3,4 5,6,8 | Green | 1.0 | 3.0 | 70° |

NOTE:

1. $\Theta 1/2$ is the off-axis angle at which the Luminous Intensity is half the axial luminous intensity.

# Absolute Maximum Ratings at $T_A = 25°C$

| Parameter | Red | High Efficiency Red | Yellow | Green | Units |
|---|---|---|---|---|---|
| Peak Forward Current | 1000 | 60 | 60 | 60 | mA |
| DC Current | 50[1] | 30[2] | 20[1] | 30[2] | mA |
| Power Dissipation | 100 | 120 | 120 | 120 | mW |
| Operating and Storage Temperature Range | -55° C to 100° C | | | | |
| Lead Soldering Temperature 1.6 mm [(0.063 in.) from Body] | 260° C for 3 seconds | | | | |

NOTES: 1. Derate from 50° C at 0.2 mA/° C.
2. Derate from 50° C at 0.5 mA/° C.

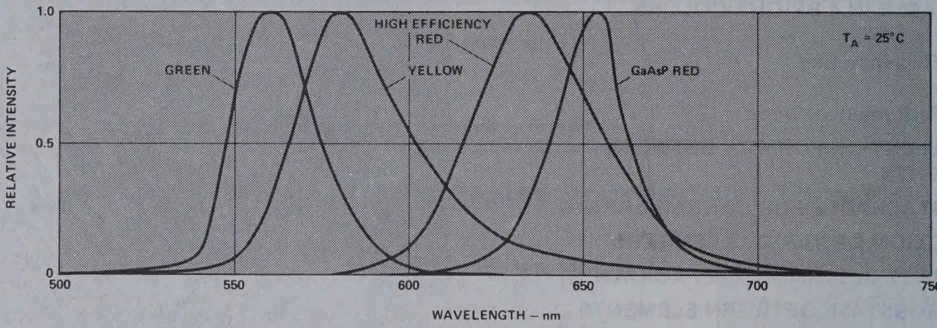


**Figure 1. Relative Intensity vs. Wavelength.**

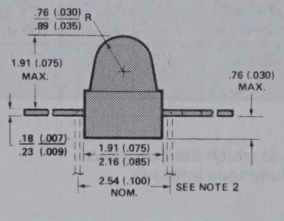
# Electrical/Optical Characteristics at $T_A = 25°C$

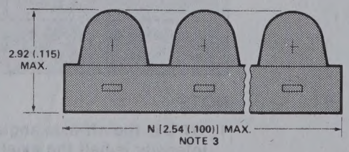
| Symbol | Description | HLMP-62XX | | | HLMP-665X | | | HLMP-675X | | | HLMP-685X | | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| $\lambda_{PEAK}$ | Peak Wavelength | | 655 | | | 635 | | | 583 | | | 565 | | nm | Measurement at Peak |
| $\lambda_d$ | Dominant Wavelength | | 640 | | | 629 | | | 585 | | | 569 | | nm | Note 1. |
| $\tau_S$ | Speed of Response | | 15 | | | 90 | | | 90 | | | 500 | | ns | |
| C | Capacitance | | 100 | | | 11 | | | 15 | | | 18 | | pF | $V_F$=0; f=1 MHz |
| $\Theta_{JC}$ | Thermal Resistance | | 125 | | | 120 | | | 100 | | | 100 | | °C/W | Junction to Cathode Lead at 0.79mm (.031 in) from Body |
| $V_F$ | Forward Voltage | 1.4 | 1.6 | 2.0 | 1.5 | 2.2 | 3.0 | 1.5 | 2.2 | 3.0 | 1.5 | 2.3 | 3.0 | V | $I_F$=10mA, Figures 2, 7, 12, 17 |
| $BV_R$ | Reverse Breakdown Voltage | 3.0 | 10 | | 5.0 | 15 | | 5.0 | 15 | | 5.0 | 20 | | V | $I_R = 100\mu A$ |
| $\eta_V$ | Luminous Efficacy | | 55 | | | 147 | | | 570 | | | 630 | | lm/W | Note 2. |

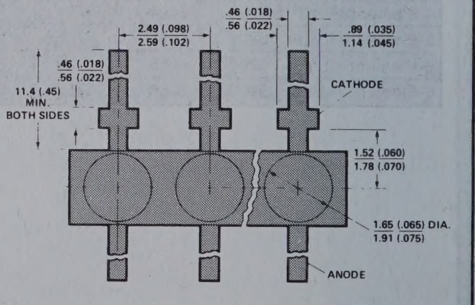
NOTES:
1. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
2. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

# Package Dimensions

Notes:
1. All dimensions are in millimetres (inches).
2. Optional lead form available.
3. Overall length is the number of elements times 2.54mm (.100 in.).


.76 (.030)
.89 (.035)
R
1.91 (.075)
MAX.
.76 (.030)
MAX.
.18 (.007)
.23 (.009)
1.91 (.075)
2.16 (.085)
2.54 (.100)
NOM.
SEE NOTE 2


2.92 (.115)
MAX.
N [2.54 (.100)] MAX.
NOTE 3


.46 (.018)
.56 (.022)
2.49 (.098)
2.59 (.102)
.89 (.035)
1.14 (.045)
.46 (.018)
.56 (.022)
11.4 (.45)
MIN.
BOTH SIDES
CATHODE
1.52 (.060)
1.78 (.070)
1.65 (.065) DIA.
1.91 (.075)
ANODE

# Red HLMP-62XX Series

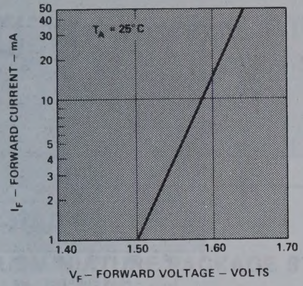


Figure 2. Forward Current vs. Forward Voltage.

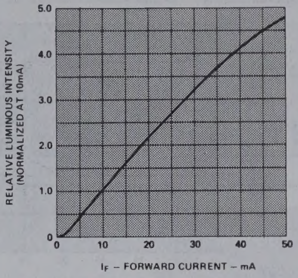


Figure 3. Relative Luminous Intensity vs. Forward Current.

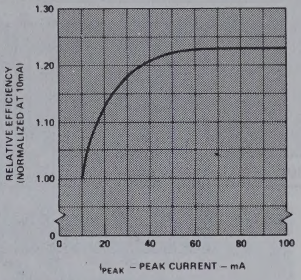


Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

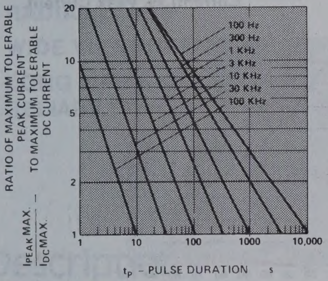


Figure 5. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

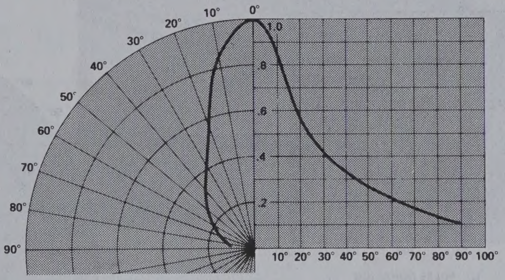


Figure 6. Relative Luminous Intensity vs. Angular Displacement.

# High Efficiency Red HLMP-665X Series

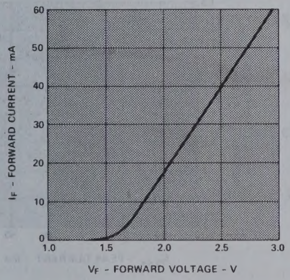


Figure 7. Forward Current vs. Forward Voltage.

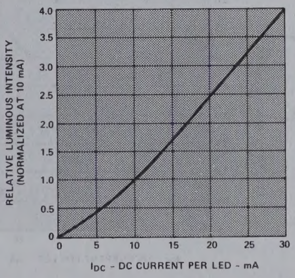


Figure 8. Relative Luminous Intensity vs. DC Forward Current.

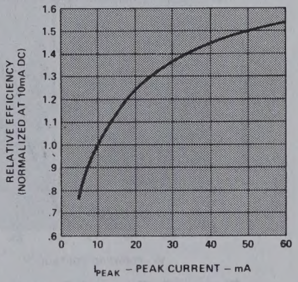


Figure 9. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

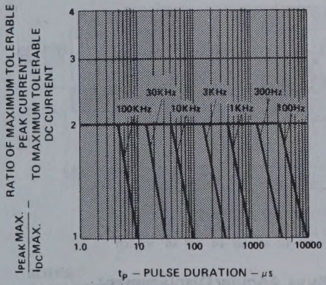


Figure 10. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

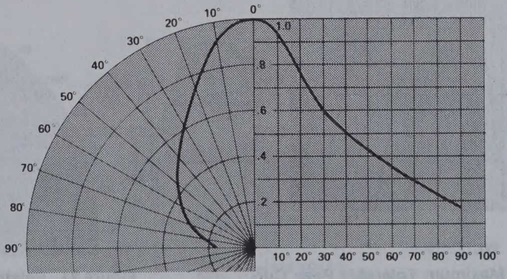


Figure 11. Relative Luminous Intensity vs. Angular Displacement.

# Yellow HLMP-675X Series

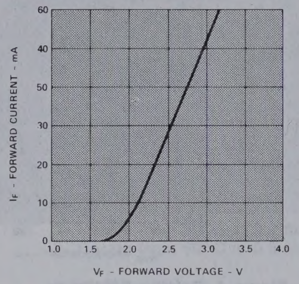


Figure 12. Forward Current vs. Forward Voltage.

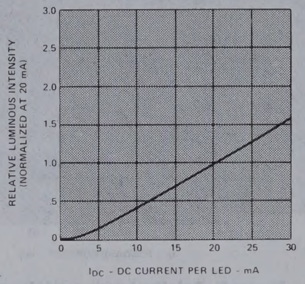


Figure 13. Relative Luminous Intensity vs. DC Forward Current.

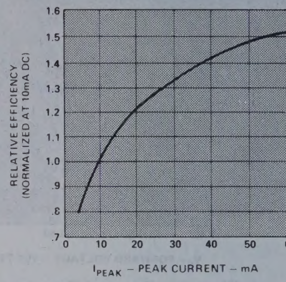


Figure 14. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

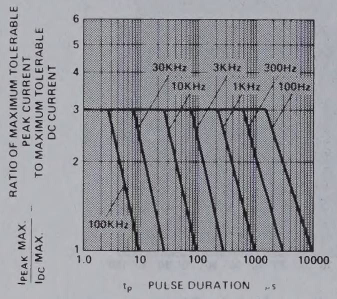


Figure 15. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

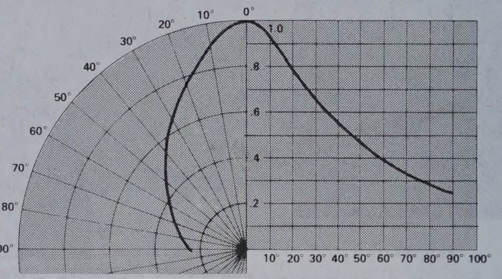


Figure 16. Relative Luminous Intensity vs. Angular Displacement.

# Green HLMP-685X Series

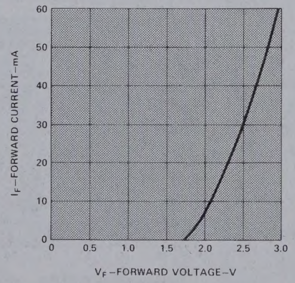


Figure 17. Forward Current vs. Forward Voltage.

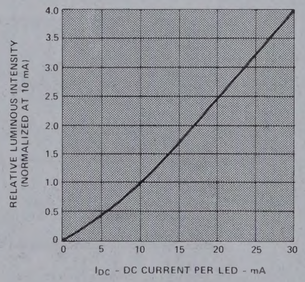


Figure 18. Relative Luminous Intensity vs. DC Forward Current.

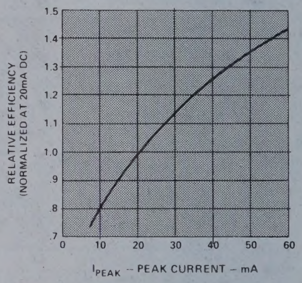


Figure 19. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

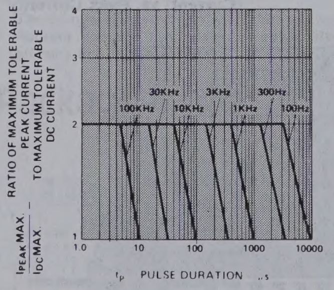


Figure 20. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

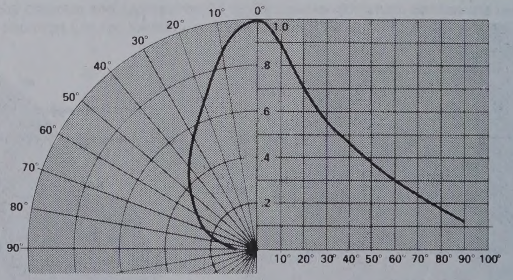


Figure 21. Relative Luminous Intensity vs. Angular Displacement.

HEWLETT PACKARD

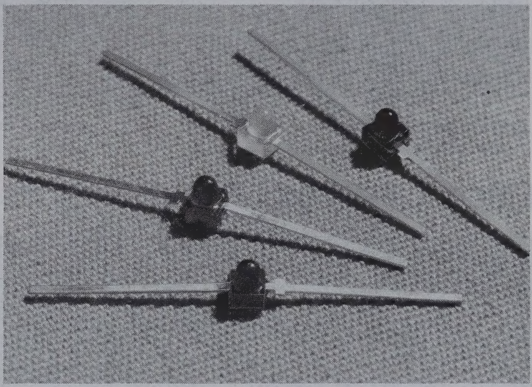
# SUBMINIATURE SOLID STATE LAMPS

RED ● HLMP-6000/6001 (5082-4100/-4101)
HIGH EFFICIENCY RED ● HLMP-6300 (5082-4160)
YELLOW ● HLMP-6400 (5082-4150)
HIGH PERFORMANCE GREEN ● HLMP-6500 (5082-4190)

TECHNICAL DATA FEBRUARY 1982

## Features

- **SUBMINIATURE PACKAGE STYLE**
- **END STACKABLE**
- **LOW PACKAGE PROFILE**
- **RADIAL LEADS**
- **WIDE VIEWING ANGLE**
- **LONG LIFE — SOLID STATE RELIABILITY**



## Description

The 6xxx are solid state lamps encapsulated in a radial lead subminiature package of molded epoxy. They utilize a tinted, diffused lens providing high on-off contrast and wide angle viewing.

The 6000/6001 utilizes a GaAsP LED chip in a deep red molded package.

The 6300 has a high-efficiency red GaAsP on GaP LED chip in a light red molded package.

The 6400 provides a yellow GaAsP on GaP LED chip in a yellow molded package.

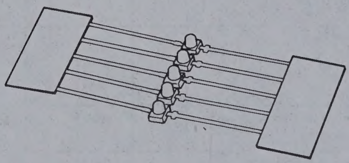
The 6500 provides a green GaP LED chip in a green molded package.

Special lead bending is available on 2.54mm (.100 in) and 5.08mm (.200 in) centers.

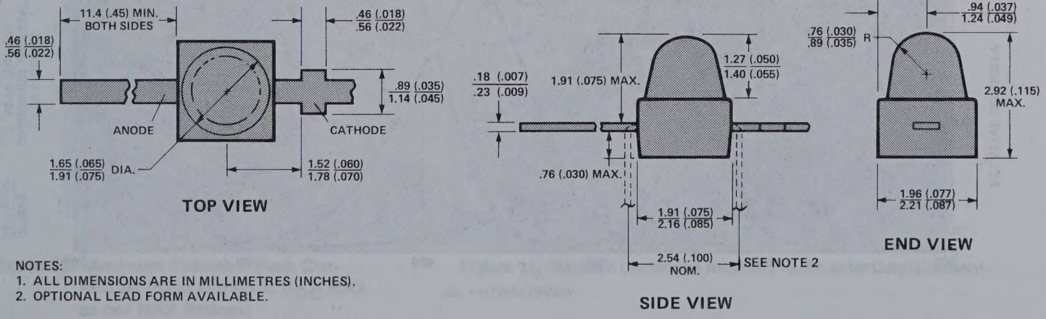
Tape-and-reel mounting is available on request.

### Tape and Reel Order Chart

| Std. Product HLMP- | 6000 | 6001 | 6300 | 6400 | 6500 |
|---|---|---|---|---|---|
| Tape & Reel P/N | HLMP-6020 | HLMP-6021 | HLMP-6320 | HLMP-6420 | HLMP-6520 |



## Package Dimensions


11.4 (.45) MIN.
BOTH SIDES
.46 (.018)
.56 (.022)
.46 (.018)
.56 (.022)
.89 (.035)
1.14 (.045)
ANODE
CATHODE
1.65 (.065)
1.91 (.075)
DIA.
1.52 (.060)
1.78 (.070)
TOP VIEW
.18 (.007)
.23 (.009)
1.91 (.075) MAX.
1.27 (.050)
1.40 (.055)
.76 (.030) MAX.
1.91 (.075)
2.16 (.085)
2.54 (.100)
NOM.
SEE NOTE 2
SIDE VIEW
.76 (.030)
.89 (.035)
R
.94 (.037)
1.24 (.049)
2.92 (.115)
MAX.
1.96 (.077)
2.21 (.087)
END VIEW

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. OPTIONAL LEAD FORM AVAILABLE.

# Absolute Maximum Ratings at $T_A$=25°C

| Parameter | Red<br>HLMP-6000/1 | High Eff. Red<br>HLMP-6300 | Yellow<br>HLMP-6400 | Green<br>HLMP-6500 | Units |
|---|---|---|---|---|---|
| Power Dissipation | 100 | 120 | 120 | 120 | mW |
| DC Forward Current | 50[1] | 30[2] | 20[1] | 30[2] | mA |
| Peak Forward Current | 1000<br>See Fig. 5 | 60<br>See Fig. 10 | 60<br>See Fig. 15 | 60<br>See Fig. 20 | mA |
| Operating and Storage Temperature Range | -55°C to 100°C | | | | |
| Lead Soldering Temperature [1.6mm (0.063 in.) from body] | 260° C for 3 seconds | | | | |

1. Derate from 50° C at 0.2mA/° C
2. Derate from 50° C at 0.5 mA/° C

# Electrical/Optical Characteristics at $T_A$=25°C

| Symbol | Description | HLMP-6000/1 | | | HLMP-6300 | | | HLMP-6400 | | | HLMP-6500 | | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| $I_V$ | Axial Luminous Intensity | —/0.5 | 1.2 | | 1.0 | 3.0 | | 1.0 | 3.0 | | 1.0 | 3.0 | | mcd | $I_F$=10mA, Figs. 3,8,13,18 |
| $2\Theta_{1/2}$ | Included Angle Between Half Luminous Intensity Points | | 45 | | | 80 | | | 90 | | | 70 | | deg. | Note 1. Figures 6, 11, 16, 21 |
| $\lambda_{PEAK}$ | Peak Wavelength | | 626 | | | 635 | | | 583 | | | 565 | | nm | Measurement at Peak |
| $\lambda_d$ | Dominant Wavelength | | 640 | | | 629 | | | 585 | | | 569 | | nm | Note 2 |
| $\tau_S$ | Speed of Response | | 15 | | | 90 | | | 90 | | | 500 | | ns | |
| C | Capacitance | | 100 | | | 11 | | | 15 | | | 18 | | pF | $V_F$=0; f=1 MHz |
| $\Theta_{JC}$ | Thermal Resistance | | 125 | | | 120 | | | 100 | | | 100 | | °C/W | Junction to Cathode Lead at 0.79mm (.031 in) from Body |
| $V_F$ | Forward Voltage | 1.4 | 1.6 | 2.0 | 1.5 | 2.2 | 3.0 | 1.5 | 2.2 | 3.0 | 1.5 | 2.3 | 3.0 | V | $I_F$=10mA, Figures 2, 7, 12, 17 |
| $V_{BR}$ | Reverse Breakdown Voltage | 3.0 | 10 | | 5.0 | 15 | | 5.0 | 15 | | 5.0 | 20 | | V | $I_R$ = 100$\mu$A |
| $\eta_V$ | Luminous Efficacy | | 55 | | | 147 | | | 570 | | | 630 | | lm/W | Note 3 |

NOTES:
1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e=I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.

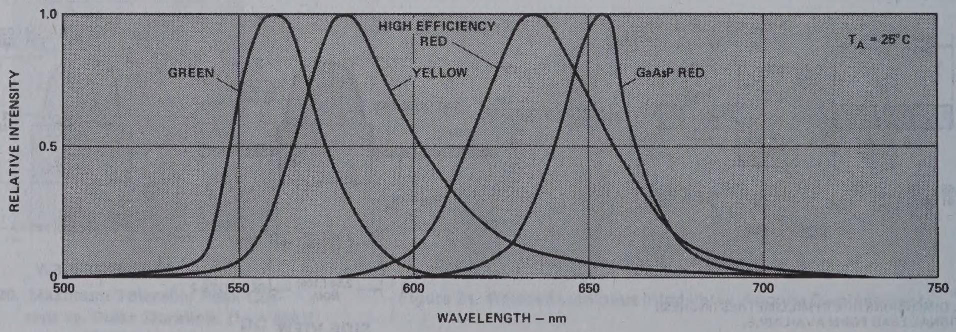


Figure 1. Relative Intensity vs. Wavelength.

# HLMP-6000/6001

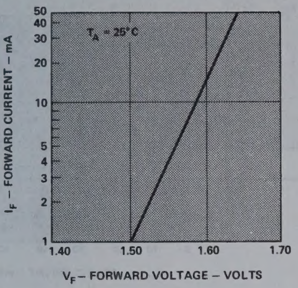


**Figure 2. Forward Current vs. Forward Voltage.**

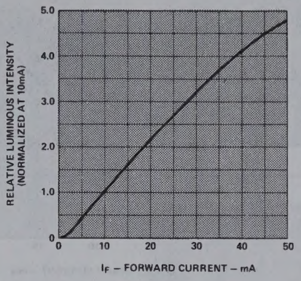


**Figure 3. Relative Luminous Intensity vs. Forward Current.**

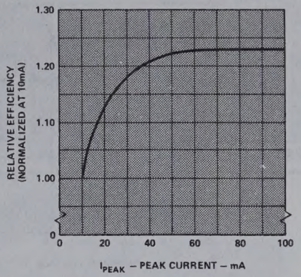


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.**

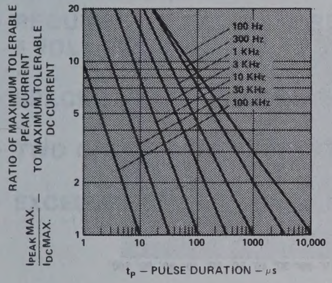


**Figure 5. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

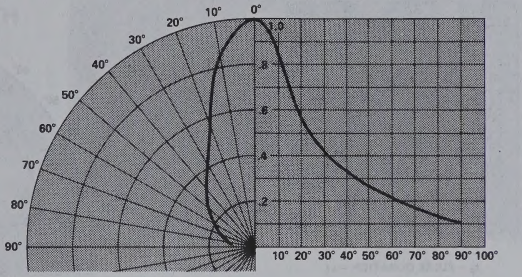


**Figure 6. Relative Luminous Intensity vs. Angular Displacement.**

# High Efficiency Red HLMP-6300

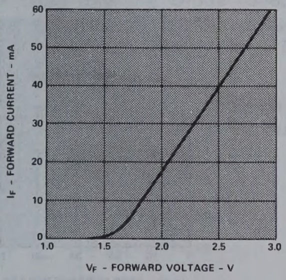


**Figure 7. Forward Current vs. Forward Voltage Characteristics**

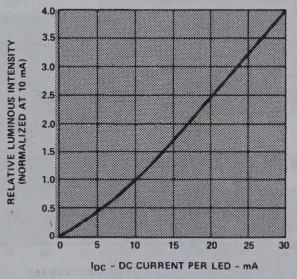


**Figure 8. Relative Luminous Intensity vs. Forward Current.**

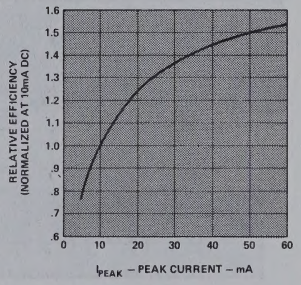


**Figure 9. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.**

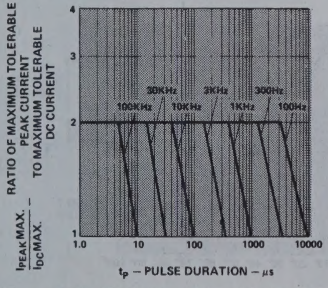


**Figure 10. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

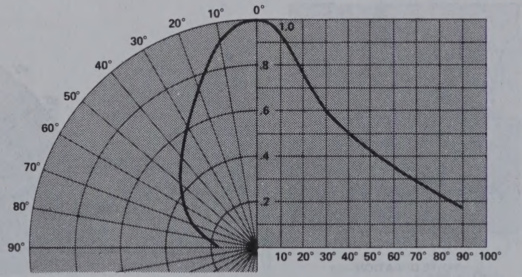


**Figure 11. Relative Luminous Intensity vs. Angular Displacement.**

# Yellow HLMP-6400

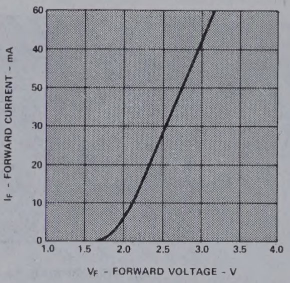


Figure 12. Forward Current vs. Forward Voltage Characteristics

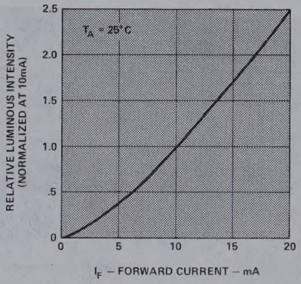


Figure 13. Relative Luminous Intensity vs. Forward Current.

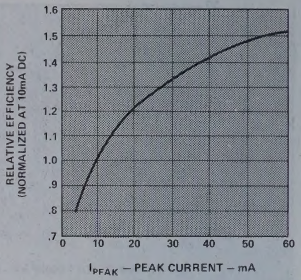


Figure 14. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

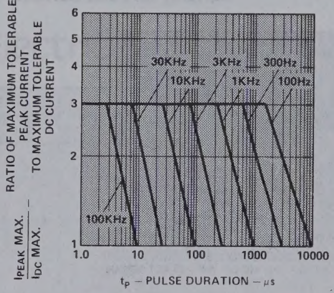


Figure 15. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

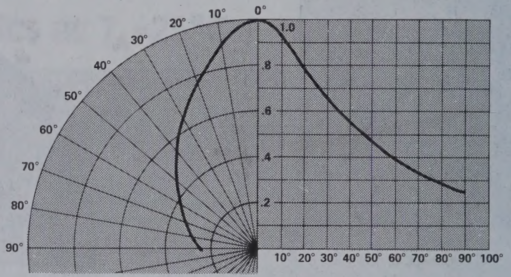


Figure 16. Relative Luminous Intensity vs. Angular Displacement.

# Green HLMP-6500

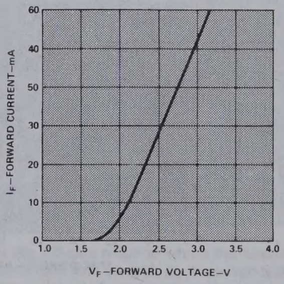


Figure 17. Forward Current vs. Forward Voltage.

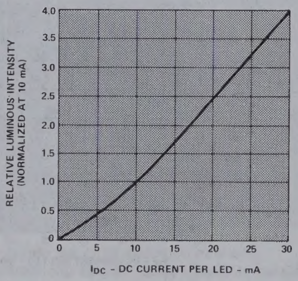


Figure 18. Relative Luminous Intensity vs. DC Forward Current

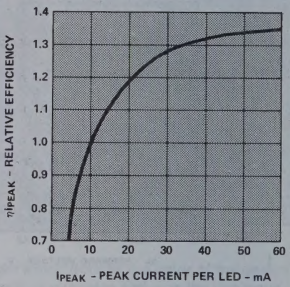


Figure 19. Relatiave Efficiency (Luminous Intensity per Unit Current) vs. Peak LED Current

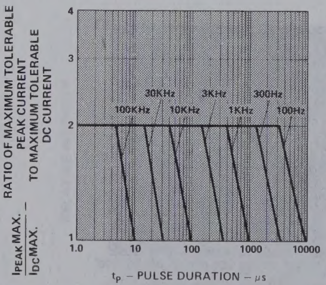


Figure 20. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

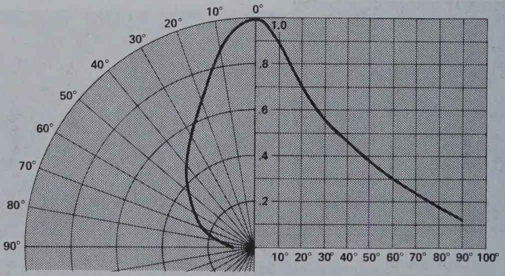


Figure 21. Relative Luminous Intensity vs. Angular Displacement.

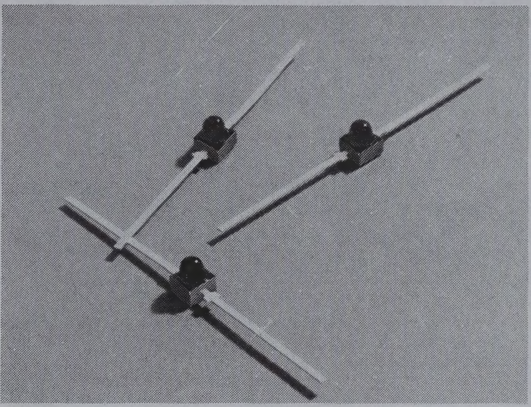
**HEWLETT PACKARD**

# SUBMINIATURE RESISTOR LAMPS
## HIGH EFFICIENCY RED
## 5 VOLT, 4mA • HLMP-6620
## 5 VOLT, 10mA • HLMP-6600

TECHNICAL DATA FEBRUARY 1982

## Features

- **IDEAL FOR TTL AND LSTTL GATE STATUS INDICATION**
- **REQUIRES NO EXTERNAL RESISTORS WITH 5 VOLT SUPPLY**
- **SPACE SAVING SUBMINIATURE PACKAGE**
- **TWO CHOICES OF CURRENT LEVEL**
- **EXCELLENT VIEWING ANGLE**



## Description

The HLMP-6600 and HLMP-6620 provide a Red Gallium Arsenide Phosphide on Gallium Phosphide Light Emitting Diode together with an integral biasing resistor. The package has a red diffused lens and radial leads. Tape-and-reel mounting is available on request.

Special lead bending is available on 2.54mm (.100 in) and 5.08mm (.200 in) centers.

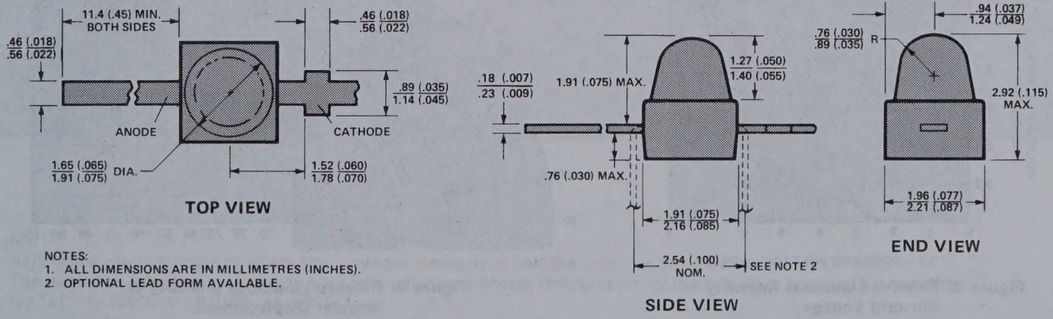
## Absolute Maximum Ratings

| | HLMP-6600/-6620 |
|---|---|
| DC Forward Voltage | 6 Volts |
| Operating Temperature Range | -55°C to 70°C |
| Storage Temperature Range | -55°C to 100°C |
| Lead Soldering Temperature [1.6mm (0.063 in.) from body] | 260°C for 3 sec. |

### Tape and Reel Order Chart

| Standard Product HLMP- | 6600 | 6620 |
|---|---|---|
| Tape & Reel P/N | HLMP-6607 | HLMP-6627 |

## Package Dimensions


11.4 (.45) MIN.
BOTH SIDES
.46 (.018)
.56 (.022)
.46 (.018)
.56 (.022)
.89 (.035)
1.14 (.045)
ANODE
CATHODE
1.65 (.065)
1.91 (.075)
DIA.
1.52 (.060)
1.78 (.070)
TOP VIEW
.18 (.007)
.23 (.009)
1.91 (.075) MAX.
1.27 (.050)
1.40 (.055)
.76 (.030) MAX.
1.91 (.075)
2.16 (.085)
2.54 (.100)
NOM.
SEE NOTE 2
SIDE VIEW
.94 (.037)
1.24 (.049)
.76 (.030)
.89 (.035)
R
2.92 (.115)
MAX.
1.96 (.077)
2.21 (.087)
END VIEW

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. OPTIONAL LEAD FORM AVAILABLE.

# Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Parameter | HLMP-6600 Min. | HLMP-6600 Typ. | HLMP-6600 Max. | HLMP-6620 Min. | HLMP-6620 Typ. | HLMP-6620 Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|
| $I_V$ | Axial Luminous Intensity | 1.0 | 2.4 | — | 0.2 | 0.6 | — | mcd | $V_F$ = 5 Volts (See Figure 3) |
| $2\Theta_{1/2}$ | Included Angle Between Half Luminous Intensity Points | | 80° | | | 80° | | | Note 1 (See Figure 4) |
| $\lambda_{PEAK}$ | Peak Wavelength | | 635 | | | 635 | | nm | Measurement at Peak |
| $\lambda_d$ | Dominant Wavelength | | 629 | | | 629 | | nm | Note 2 |
| $\Theta_j$ | Thermal Resistance | | 120 | | | 120 | | °C/W | Junction to Cathode Lead at 0.79mm (0.031 in.) From Body |
| $I_F$ | Forward Current | | 9.6 | 13 | | 3.5 | 5 | mA | $V_F$=5 Volts (See Figure 2) |
| $V_{BR}$ | Reverse Voltage | 5.0 | 15.0 | | 5.0 | 15.0 | | μA | $I_R$ = 100 μA |
| $\eta_V$ | Luminous Efficacy | | 147 | | | 147 | | lm/W | Note 3 |

NOTES:

1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_V/\eta_V$, where $I_V$ is the luminous intensity in candelas and $\eta_V$ is the luminous efficacy in lumens/watt.

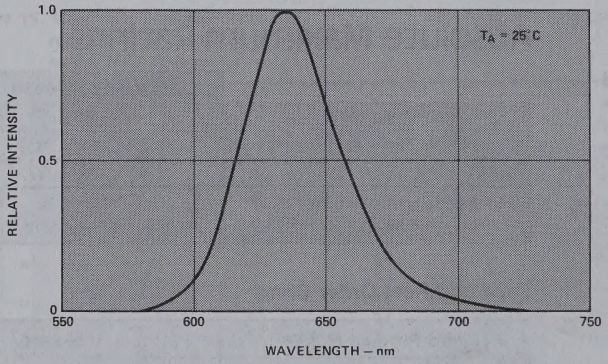


**Figure 1. Relative Intensity vs. Wavelength.**

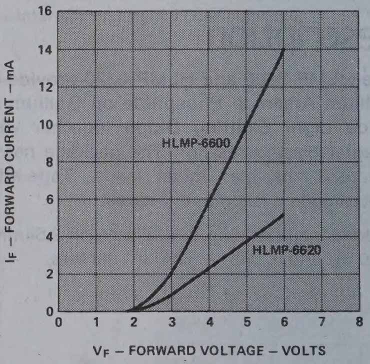


**Figure 2. Forward Current vs. Forward Voltage.**

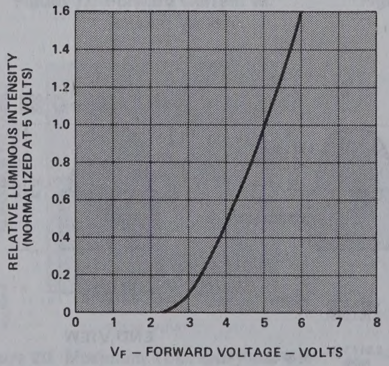


**Figure 3. Relative Luminous Intensity vs. Forward Voltage.**

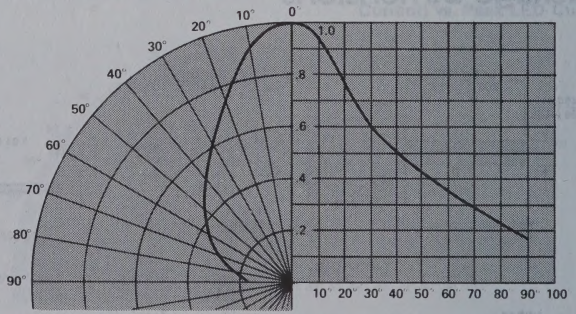


**Figure 4. Relative Luminous Intensity vs. Angular Displacement.**

HEWLETT
PACKARD

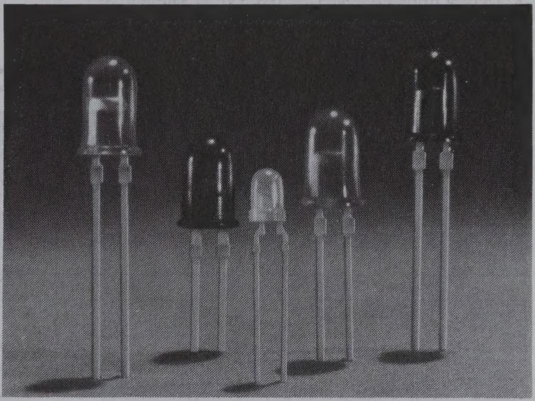
# SOLID STATE RESISTOR LAMPS

5 Volt T-1 3/4 HLMP-0280 (5082-4860)
HLMP-3105/-3600/-3650/-3680
T-1 HLMP-1120 (5082-4468)
12 Volt T-1 3/4 HLMP-3112

TECHNICAL DATA FEBRUARY 1982

## Features

- **INTEGRAL CURRENT LIMITING RESISTOR**
- **TTL COMPATIBLE: Requires no External Current Limiter with 5 Volt/12 Volt Supply**
- **COST EFFECTIVE: Space Saving**
- **WIRE WRAPPABLE LEADS**
- **WIDE VIEWING ANGLE**



## Description

The 5 volt and 12 volt series lamps contain an integral current limiting resistor in series with the LED. This allows the lamp to be driven from a 5 volt/12 volt source without the need for an external current limiter. The HLMP-1120, -0280, -3105, and -3112 lamps utilize standard red LED chips which are made from GaAsP on a GaAsP substrate. The 3600 and 3650 lamps utilize a High Efficiency Red and yellow LED chips which are made from GaAsP on a transparent GaP substrate. The 3680 lamp utilizes a High Performance Green LED chip made from GaP on a transparent GaP substrate. The diffused lamps provide a wide off-axis viewing angle.

The T-1 3/4 lamps are provided with sturdy leads suitable for wire wrappable applications. They also may be front panel mounted by using the HLMP-0103 clip and ring.

| Color | Part Number HLMP-(5082) | Package | Operating Voltage | $I_V$ mcd[2] | | 2Θ 1/2[1] | Package Outline |
|---|---|---|---|---|---|---|---|
| | | | | min. | typ. | | |
| Red | 1120 (4468) | T-1 Untinted Non-Diffused | 5 | 0.8 | 1.5 | 70° | A |
| | 0280 (4860) | Ferrule T-1 3/4 Diffused | 5 | 1.0 | 2.0 | 58° | B |
| | 3105 | T-1 3/4 Diffused | 5 | 1.0 | 2.0 | 90° | C |
| | 3112 | | 12 | 1.0 | 2.0 | 90° | C |
| High Efficiency Red | 3600 | T-1 3/4 Diffused | 5 | 1.5 | 4.0 | 90° | C |
| Yellow | 3650 | T-1 3/4 Diffused | 5 | 1.5 | 4.0 | 90° | C |
| High Performance Green | 3680 | T-1 3/4 Diffused | 5 | 1.5 | 4.0 | 90° | C |

**Notes:**
1. Θ1/2 is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The luminous intensity may be adjusted for operating ambient temperature by the following exponential equation:
$I_V(T_A) = I_V(25°C)e^{[-0.0188(T_A - 25°C)]}$

# Absolute Maximum Ratings at $T_A = 25°C$

| | 5 Volt Lamps | 12 Volt Lamps |
|---|---|---|
| DC Forward Voltage ($T_A = 25°C$) | 7.5 Volts[3] | 15 Volts[4] |
| Operating Temperature Range | -40°C to 85°C | -40°C to 85°C |
| Storage Temperature Range | -55°C to 100°C | -55°C to 100°C |
| Lead Soldering Temperature | 260°C for 5 seconds | |

**NOTES:**

3. Derate from $T_A = 50°C$ at 0.071V/°C, see Fig. 3.
4. Derate from $T_A = 50°C$ at 0.086V/°C, see Fig. 3.

# Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Parameter | Red[7] | | | HLMP-3600 | | | HLMP-3650 | | | HLMP-3680 | | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | min. | typ. | max. | min. | typ. | max. | min. | typ. | max. | min. | typ. | max. | | |
| $\lambda_{PEAK}$ | Peak Wavelength | | 655 | | | 635 | | | 583 | | | 565 | | nm | |
| $\lambda_d$ | Dominant Wavelength | | 640 | | | 626 | | | 585 | | | 569 | | nm | Note 5. |
| $R\theta_{J\text{-}PIN}$ | Thermal Resistance | | 90 | | | 90 | | | 90 | | | 90 | | °C/W | Junction to lead at 3 mm from body |
| $I_F$ | Forward Current | | 13 | 20 | | 10 | 15 | | 10 | 15 | | 12 | 15 | mA | At rated voltage |
| $\eta_V$ | Luminous Efficacy | | 55 | | | 147 | | | 570 | | | 630 | | lumens /watt | Note 6. |
| $V_{BR}$ | Reverse Breakdown Voltage | 3.0 | | | 5.0 | | | 5.0 | | | 5.0 | | | | $I_R = 100\ \mu A$ |

**Notes:**

5. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
6. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_V/\eta_V$. Where $I_V$ is the luminous intensity in candelas and $\eta_V$ is the luminous efficacy in lumens/watt.
7. GaAsP lamps HLMP-0280/-1120/-3105/-3112.

# Package Dimensions

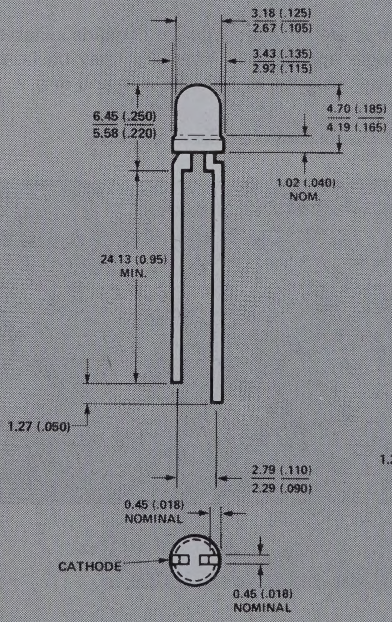

3.18 (.125)
2.67 (.105)
3.43 (.135)
2.92 (.115)
6.45 (.250)
5.58 (.220)
4.70 (.185)
4.19 (.165)
1.02 (.040)
NOM.
24.13 (0.95)
MIN.
1.27 (.050)
2.79 (.110)
2.29 (.090)
0.45 (.018)
NOMINAL
CATHODE
0.45 (.018)
NOMINAL

**Figure A. HLMP-1120.**

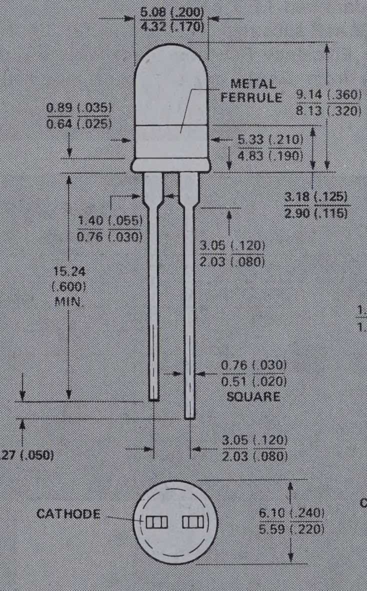

5.08 (.200)
4.32 (.170)
METAL
FERRULE
9.14 (.360)
8.13 (.320)
0.89 (.035)
0.64 (.025)
5.33 (.210)
4.83 (.190)
3.18 (.125)
2.90 (.115)
1.40 (.055)
0.76 (.030)
3.05 (.120)
2.03 (.080)
15.24
(.600)
MIN.
0.76 (.030)
0.51 (.020)
SQUARE
1.27 (.050)
3.05 (.120)
2.03 (.080)
CATHODE
6.10 (.240)
5.59 (.220)

**Figure B. HLMP-0280.**

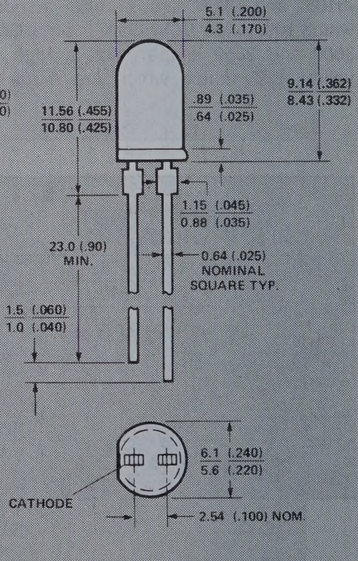

5.1 (.200)
4.3 (.170)
9.14 (.362)
8.43 (.332)
11.56 (.455)
10.80 (.425)
.89 (.035)
.64 (.025)
1.15 (.045)
0.88 (.035)
23.0 (.90)
MIN.
0.64 (.025)
NOMINAL
SQUARE TYP.
1.5 (.060)
1.0 (.040)
6.1 (.240)
5.6 (.220)
CATHODE
2.54 (.100) NOM.

**Figure C. HLMP-3105, -3112, -3600, -3650, -3680.**

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

# Standard Red HLMP-0280/-1120/-3105/-3112 Lamps

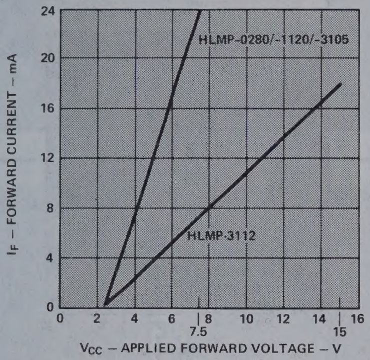


**Figure 1. Forward Current vs. Applied Forward Voltage**

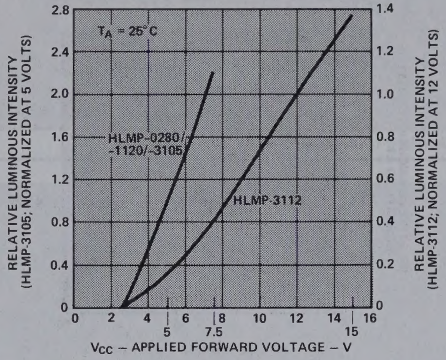


**Figure 2. Relative Luminous Intensity vs. Applied Forward Voltage**

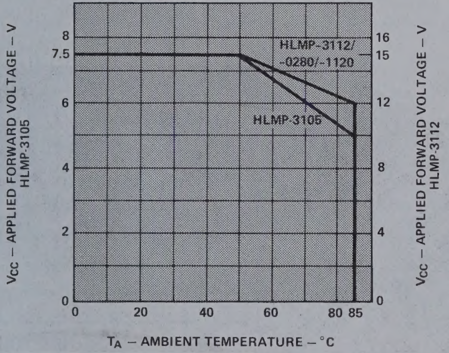


**Figure 3. Maximum Allowed Applied Forward Voltage vs. Ambient Temperature $R_{\theta JA} = 175°C/W$.**

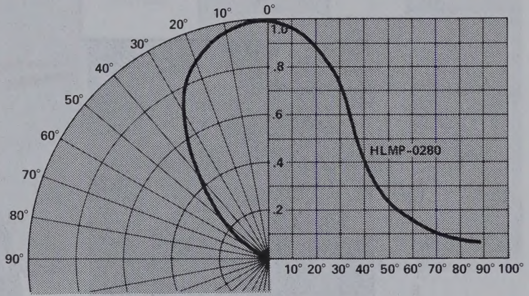


**Figure 4. Relative Luminous Intesity vs. Angular Displacement.**

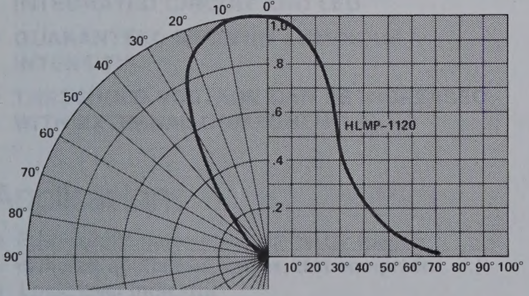


**Figure 5. Relative Luminous Intensity vs. Angular Displacement.**

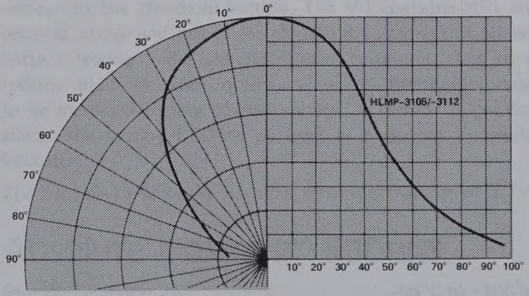


**Figure 6. Relative Luminous Intensity vs. Angular Displacement.**

# High Efficiency Red, Yellow, Green Lamps

## HLMP-3600/-3650/-3680

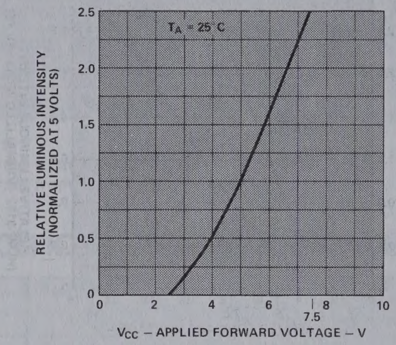


Figure 7. Relative Luminous Intensity vs. Applied Forward Voltage.

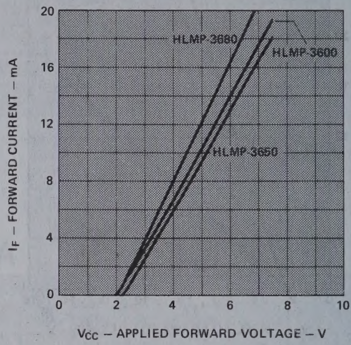


Figure 8. Forward Current vs. Applied Forward Voltage.

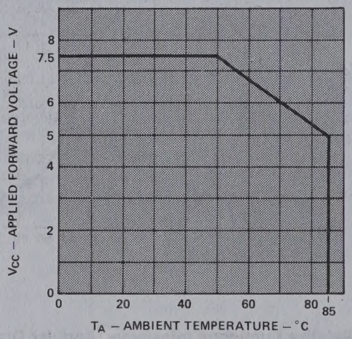


Figure 9. Relative Luminous Intensity vs. Angular Displacement.

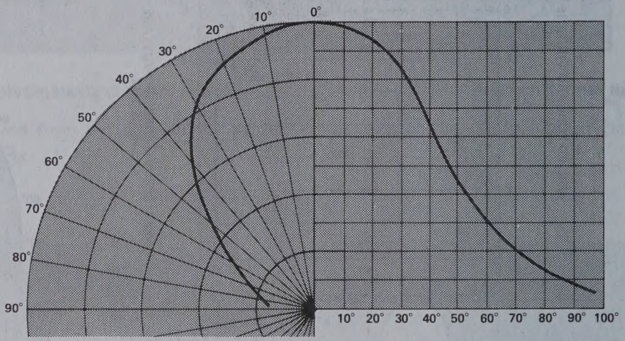


Figure 10. Max. Allowed Applied Forward Voltage vs. Ambient Temp.

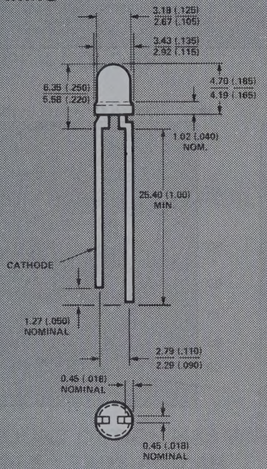
HEWLETT PACKARD

# VOLTAGE SENSING LED

## HLMP 1142 (5082-4732)

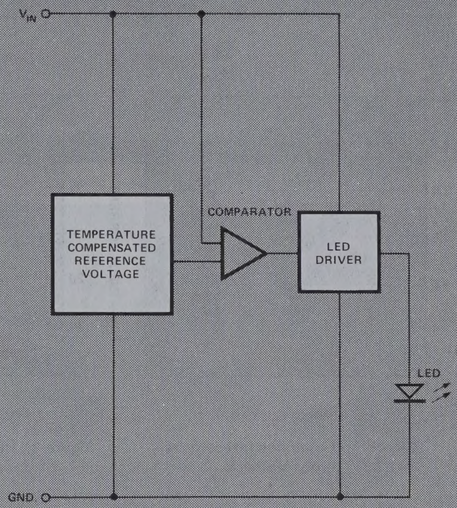
TECHNICAL DATA FEBRUARY 1982

**OUTLINE DRAWING**


3.18 (.125)
2.67 (.105)
3.43 (.135)
2.92 (.115)
6.35 (.250)
5.58 (.220)
4.70 (.185)
4.19 (.165)
1.02 (.040)
NOM.
25.40 (1.00)
MIN.
CATHODE
1.27 (.050)
NOMINAL
2.79 (.110)
2.29 (.090)
0.45 (.018)
NOMINAL
0.45 (.018)
NOMINAL

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. AN EPOXY MENISCUS MAY EXTEND ABOUT 1mm (.040") DOWN THE LEADS.

**BLOCK DIAGRAM**


$V_{IN}$
TEMPERATURE COMPENSATED REFERENCE VOLTAGE
COMPARATOR
LED DRIVER
LED
GND

## Features

- **HIGH SENSITIVITY: 10mV ON TO OFF**
- **BUILT IN LED CURRENT LIMITING**
- **TEMPERATURE COMPENSATED THRESHOLD VOLTAGE**
- **COMPACT: PACKAGE INCLUDES INTEGRATED CIRCUIT AND LED**
- **GUARANTEED MINIMUM LUMINOUS INTENSITY**
- **THRESHOLD VOLTAGE CAN BE INCREASED WITH EXTERNAL COMPONENT**

## Applications

- Push-to-test battery voltage tester (pagers, cameras, appliances, radios, test equipment. . .)
- Logic level indicator
- Power supply voltage monitor
- V-U meter
- Analog level sense
- Voltage indicating arrays — use several with different thresholds
- Current monitor

## Description

The HP voltage sensing LEDs use an integrated circuit and a red GaAsP LED to provide a complete voltage sensing function in a standard red diffused T-1 LED package. When the input voltage ($V_{IN}$) exceeds the threshold voltage ($V_{TH}$) the LED turns "on". The high gain of the comparator provides unambiguous indication by the LED of the input voltage with respect to the threshold voltage. The V-I characteristics are resistive above and below the threshold voltage. This allows battery testing under simulated load conditions. Use of a resistor, diode or zener in series allows the threshold voltage to be increased to any desired voltage. A resistor in parallel allows the sensing LED to be used as a current threshold indicator.

The HLMP-1142 has a nominal threshold voltage of 2.7V.

## Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature | -55°C to +100°C |
| Operating Temperature | -55°C to +85°C |
| Lead Solder Temperature | 230°C for 7 Sec |
| Input Voltage — $V_{IN}$ [1] | +5V dc |
| Reverse Input Voltage — $V_R$ | -0.5V |

NOTES:

1. Derate linearly above 50°C free-air temperature at a rate of 37mV/°C.

# Electro-Optical Characteristics at $T_A = 25°C$

| Parameter | Sym. | HLMP-1142 |  |  | Units | Test Conditions | Fig. |
|---|---|---|---|---|---|---|---|
|  |  | Min. | Typ. | Max. |  |  |  |
| Threshold Voltage | $V_{TH}$ | 2.5 | 2.7 | 2.9 | V |  | 1,2 |
| Temperature Coefficient of Threshold | $\frac{\Delta V_{TH}}{\Delta T_A}$ |  | −1 |  | mV/°C |  |  |
| Input Current | $I_{IN}$ |  | 13 |  | mA | $V_{IN} = 2.75V$ | 2 |
|  |  |  | 33 | 50 | mA | $V_{IN} = 5.0V$ | 2 |
| Luminous Intensity | $I_v$ | 0.3 | 0.7 |  | mcd | $V_{IN} = 2.75V$ | 1 |
| Wavelength | $\lambda_{PEAK}$ |  | 655 |  | nm | Measurement at peak |  |
| Dominant Wavelength | $\lambda_d$ |  | 640 |  | nm | Note 1 |  |

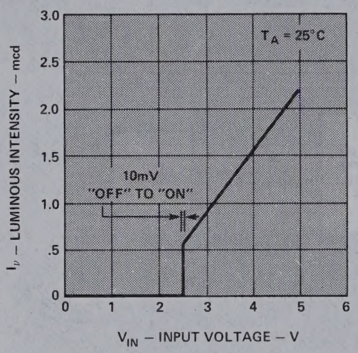


Figure 1. Luminous Intensity vs. Input Voltage.

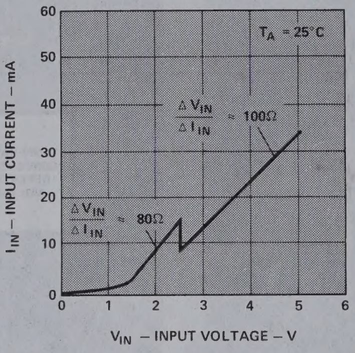


Figure 2. Input Current vs. Input Voltage.

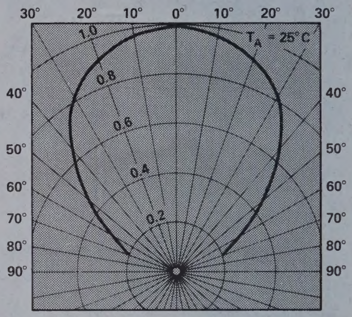
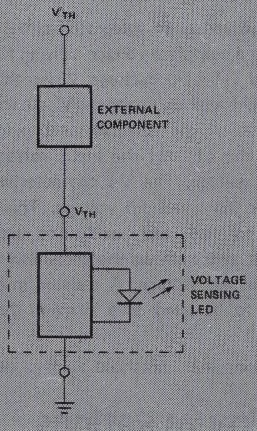
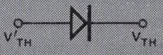
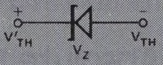


Figure 3. Relative Luminous Intensity vs. Angular Displacement.

# Techniques For Increasing The Threshold Voltage



| External Component |  | $V'_{TH}$ | $TC = \frac{\Delta V'_{TH}}{\Delta T_A}$ (mV/°C) |
|---|---|---|---|
| | Schottky Diode<br>(HP 5082-2835) | $V_{TH} + 0.45V$ | −2 |
|  | P-N Diode<br>(1N914) | $V_{TH} + 0.75V$ | −2.5 |
| | LED<br>(HLMP-1000) | $V_{TH} + 1.6V$ | −2.9 |
|  | Zener Diode | $V_{TH} + V_Z$ | −1 + Zener TC |

Notes:
1. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
2. $I_{TH}$ is the maximum current just below the threshold, $V_{TH}$. Since both $I_{TH}$ and $V_{TH}$ are variable, a precise value of $V'_{TH}$ is obtainable only by selecting R to fit the measured characteristics of the individual devices (e.g., with curve tracer).
3. The temperature coefficient (TC) will be a function of the resistor TC and the value of the resistor.

HEWLETT PACKARD

# JAN QUALIFIED HERMETIC SOLID STATE LAMPS*

IN5765
JANIN5765
JANTXIN5765
IN6092
JANIN6092
JANTXIN6092
IN6093
JANIN6093
JANTXIN6093
IN6094
JANIN6094
JANTXIN6094

TECHNICAL DATA FEBRUARY 1982

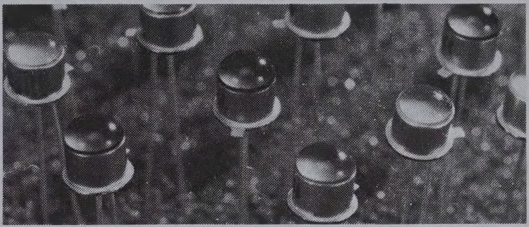
## Features

- **MILITARY QUALIFICATION**
- **CHOICE OF 4 COLORS**
  - **Red**
  - **High Efficiency Red**
  - **Yellow**
  - **Green**
- **DESIGNED FOR HIGH-RELIABILITY APPLICATIONS**
- **HERMETICALLY SEALED**
- **WIDE VIEWING ANGLE**
- **LOW POWER OPERATION**
- **IC COMPATIBLE**
- **LONG LIFE**
- **PANEL MOUNT OPTION HAS WIRE WRAPPABLE LEADS AND AN ELECTRICALLY ISOLATED CASE**

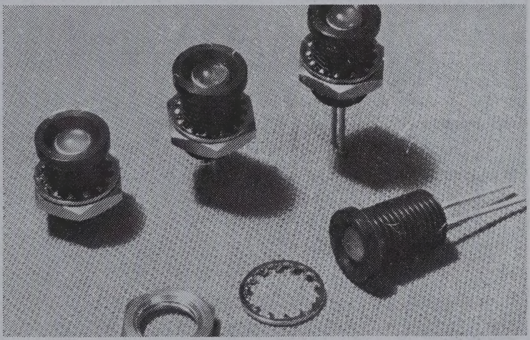
## Description

The 1N5765, 1N6092, 1N6093, and 1N6094 are hermetically sealed solid state lamps encapsulated in a TO-46 package with a tinted diffused plastic lens over a glass window. These hermetic lamps provide good on-off contrast, high axial luminous intensity and a wide viewing angle.

All of these devices are available in a panel mountable fixture. The semiconductor chips are packaged in a hermetically sealed TO-46 package with a tinted diffused plastic lens over glass window. This TO-46 package is then encapsulated in a panel mountable fixture designed for high reliability applications. The encapsulated LED lamp assembly provides a high on-off contrast, a high axial luminous intensity and a wide viewing angle.



**HERMETIC TO-46 LAMP**



**PANEL MOUNT AS LAMP ASSEMBLY**

The 1N5765 utilizes a GaAsP LED chip with a red diffused plastic lens over glass window.

The 1N6092 has a high efficiency red GaAsP on GaP LED chip with a red diffused plastic lens over glass window. This lamp's efficiency is comparable to that of a GaP red but extends to higher current levels.

The 1N6093 provides a yellow GaAsP on GaP LED chip with a yellow diffused plastic lens over glass window.

The 1N6094 provides a green GaP LED chip with a green diffused plastic lens over glass window.

Part marking includes: part number from matrix below, CAQI designating code and YYWWX lot identification code including year, week and assembly plant if required.

**COLOR — PART NUMBER — PANEL MOUNT MATRIX**

| Description | Standard Product | With JAN Qualification[1] | Jan Plus TX Testing[2] | Controlling MIL-S-19500 Document[4] |
|---|---|---|---|---|
| **TABLE I HERMETIC TO-46 PART NUMBER SYSTEM** | | | | |
| Standard Red | IN5765 | JANIN5765 | JANTXIN5765 | /467 |
| High Efficiency Red | IN6092 | JANIN6092 | JANTXIN6092 | /519 |
| Yellow | IN6093 | JANIN6093 | JANTXIN6093 | /520 |
| Green | IN6094 | JANIN6094 | JANTXIN6094 | /521 |
| **TABLE II PANEL MOUNTABLE PART NUMBER SYSTEM[3]** | | | | |
| Standard Red | 5082-4787 | HLMP-0930 | HLMP-0931 | NONE |
| High Efficiency Red | 5082-4687 | MI9500/519-01 | MI9500/519-02 | /519 |
| Yellow | 5082-4587 | MI9500/520-01 | MI9500/520-02 | /520 |
| Green | 5082-4987 | MI9500/521-01 | MI9500/521-02 | /521 |

**Notes:**

1. Parts are marked JINXXXX or as indicated.
2. Parts are marked JTX INXXXX or as indicated.
3. Panel mountable packaging incorporates additional assembly of the equivalent Table I TO-46 part into the panel mount enclosure. The resulting part is then marked per Table II.
4. JAN and JANTX parts only.

*Panel mount versions of all of the above are available per the selection matrix on this page.

JAN PART: Samples of each lot are subjected to Group A, B and C tests listed below. All tests are to the conditions and limits specified by the appropriate MIL-S-19500 slash sheet for the device under test. A summary of the data gathered in Groups A, B and C lot acceptance testing is supplied with each shipment.

| Examination or Test | MIL-STD-750 Method |
|---|---|
| **GROUP A INSPECTION** | |
| **Subgroup 1** | |
| Visual and mechanical examination | 2071 |
| **Subgroup 2** | |
| Luminous intensity ($\theta = 0°$) | — |
| Luminous intensity ($\theta = 30°$) | — |
| Reverse current | 4016 |
| Forward voltage | 4011 |
| **Subgroup 3** | |
| Capacitance | 4001 |
| **GROUP B INSPECTION** | |
| **Subgroup 1** | |
| Physical dimensions | 2066 |
| **Subgroup 2** | |
| Solderability | 2026 |
| Thermal shock (temperature cycling) | 1051 |
| Thermal shock (glass strain) | 1056 |
| Hermetic seal | 1071 |
| Moisture resistance | 1021 |
| End points: Luminous intensity ($\theta = 0°$) | — |
| **Subgroup 3** | |
| Shock | 2016 |
| Vibration, variable frequency | 2056 |
| Constant acceleration | 2006 |
| End points: (same as subgroup 2) | |
| **Subgroup 4** | |
| Terminal strength | 2036 |
| End points: Hermetic seal | 1071 |
| **Subgroup 5** | |
| Salt atmosphere (corrosion) | 1041 |
| **Subgroup 6** | |
| High-temperature life (nonoperating) | 1032 |
| End points: Luminous intensity ($\theta = 0°$) | — |
| **Subgroup 7** | |
| Steady-state operation life | 1027 |
| End points: (same as subgroup 6) | |

JANTX PART: Devices undergo 100% screening tests as listed below to the conditions and limits specified by MIL-S-19500 slash sheet. The JANTX lot has also been subjected to Group A, B and C tests as for the JAN PART above. A summary of the data gathered in Groups A, B and C acceptance testing is supplied with each shipment.

| Examination or Test | MIL-STD-750 Method |
|---|---|
| **GROUP C INSPECTION** | |
| **Subgroup 1** | |
| Thermal shock (temperature cycling) | 1051 |
| End points: (same as subgroup 2 of group B) | |
| **Subgroup 2** | |
| Resistance to solvents | — |
| **Subgroup 3** | |
| High-temperature life (nonoperating) | 1031 |
| End points: Luminous intensity ($\theta = 0°$) | — |
| **Subgroup 4** | |
| Steady-state operation life | 1026 |
| End points: (same as subgroup 3) | |
| **Subgroup 5** | |
| Peak forward pulse current (transient) | — |
| End points: (same as subgroup 6 of group B) | |
| **Subgroup 6** | |
| Peak forward pulse current (operating) | — |
| End points: (same as subgroup 6 of group B) | |
| **PROCESS AND POWER CONDITION ("TX" types only)** | |
| High temperature storage (nonoperating) | — |
| Thermal shock (temperature cycling) | 1051 |
| Constant acceleration | 2006 |
| Hermetic seal | 1071 |
| Luminous intensity ($\theta = 0°$) | — |
| Forward voltage | 4011 |
| Reverse current | 4016 |
| Burn-in (Forward bias) | — |
| End points (within 72 hours of burn-in): | |
| $\Delta$ Luminous intensity ($\theta = 0°$) | — |
| $\Delta$ Forward voltage | 4011 |

# Absolute Maximum Ratings at $T_A$=25°C

| Parameter | Red<br>1N5765/4787 | High Eff. Red<br>1N6092/4687 | Yellow<br>1N6093/4587 | Green<br>1N6094/4987 | Units |
|---|---|---|---|---|---|
| Power Dissipation (derate linearly from 50°C at 1.6mW/°C) | 100 | 120 | 120 | 120 | mW |
| DC Forward Current | 50[1] | 35[2] | 35[2] | 35[2] | mA |
| Peak Forward Current | 1000<br>See Fig. 5 | 60<br>See Fig. 10 | 60<br>See Fig. 15 | 60<br>See Fig. 20 | mA |
| Operating and Storage Temperature Range | -65°C to 100°C | | | | |
| Lead Soldering Temperature [1.6mm (0.063 in.) from body] | 260°C for 7 seconds. | | | | |

**Notes:** 1. Derate from 50°C at 0.2mA/°C 2. Derate from 50°C at 0.5mA/°C

# Electrical/Optical Characteristics at $T_A$=25°C

| Symbol | Description | 1N5765/5082-4787 | | | 1N6092/5082-4687 | | | 1N6093/5082-4587 | | | 1N6094/5082-4987 | | | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | | |
| $I_{V1}$ | Axial Luminous Intensity | 0.5 | 1.0 | | 1.0 | 2.5 | | 1.0 | 2.5 | | 0.8 | 1.6<br>At $I_F$ = 25mA | | mcd | $I_F$ = 20mA<br>Figs. 3,8,13,18<br>$\theta = 0°$ |
| $I_{V2}$ | Luminous Intensity at $\theta$ = 30°[5] | 0.3 | | | 0.5 | | | 0.5 | | | 0.4 | | | mcd | $I_F$ = 20 mA<br>$\theta = 30°$ |
| $2\Theta_{1/2}$ | Included Angle Between Half Luminous Intensity Points | | 60 | | | 70 | | | 70 | | | 70 | | deg. | [1] Figures 6, 11, 16, 21 |
| $\lambda_{PEAK}$ | Peak Wavelength[5] | 630 | 655 | 700 | 590 | 635 | 695 | 550 | 583 | 660 | 525 | 565 | 600 | nm | Measurement at Peak |
| $\lambda_d$ | Dominant Wavelength | | 640 | | | 626 | | | 585 | | | 570 | | nm | [2] |
| $\tau_S$ | Speed of Response | | 10 | | | 200 | | | 200 | | | 200 | | ns | |
| C | Capacitance[5] | | 200 | 300 | | 35 | 100 | | 35 | 100 | | 35 | 100 | pF | $V_F$=0; f=1 MHz |
| $\Theta_{JC}$ | Thermal Resistance* | | 425 | | | 425 | | | 425 | | | 425 | | °C/W | [3] |
| $\Theta_{JC}$ | Thermal Resistance** | | 550 | | | 550 | | | 550 | | | 550 | | °C/W | [3] |
| $V_F$ | Forward Voltage | | 1.6 | 2.0 | | 2.0 | 3.0 | | 2.0 | 3.0 | | 2.1<br>At $I_F$ = 25mA | 3.0 | V | $I_F$ = 20mA<br>Figures 2, 7, 12, 17 |
| $I_R$ | Reverse Current[5] | | | 1.0 | | | 1.0 | | | 1.0 | | | 1.0 | μA | $V_R$ = 3V |
| $BV_R$ | Reverse Breakdown Voltage | 4 | 5 | | 5.0 | | | 5.0 | | | 5.0 | | | V | $I_R$ = 100μA |
| $\eta_V$ | Luminous Efficacy | | 56 | | | 140 | | | 455 | | | 600 | | lm/W | [4] |

NOTES:

1. $\Theta_{1/2}$ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. The dominant wavelength, $\lambda_d$, is derived from the CIE chromaticity diagram and represents the single wavelength which defines the color of the device.
3. Junction to Cathode Lead with 3.18mm (0.125 inch) of leads exposed between base of flange and heat sink.
4. Radiant intensity, $I_e$, in watts/steradian, may be found from the equation $I_e = I_v/\eta_v$, where $I_v$ is the luminous intensity in candelas and $\eta_v$ is the luminous efficacy in lumens/watt.
5. Limits do not apply to non JAN parts.

*Panel mount.

**T0-46

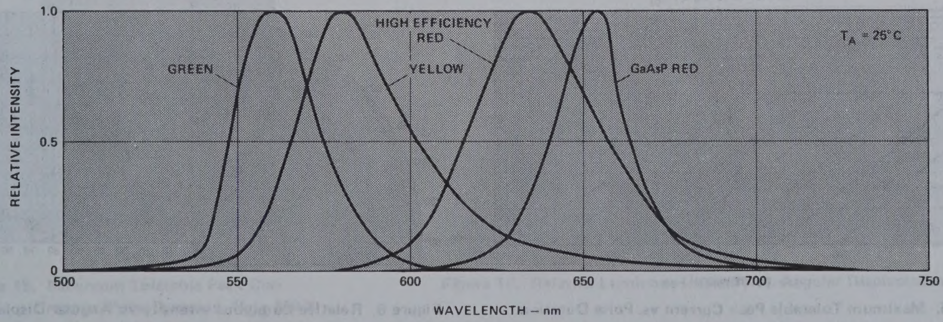
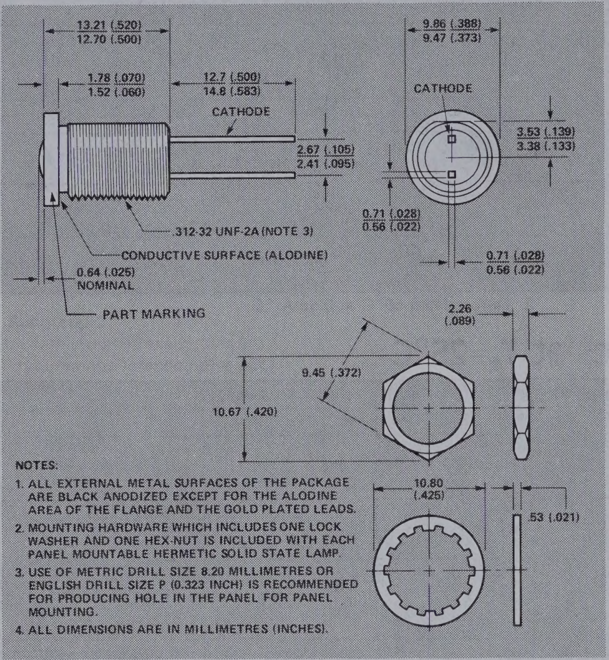


Figure 1. Relative Intensity vs. Wavelength.

# Package Dimensions

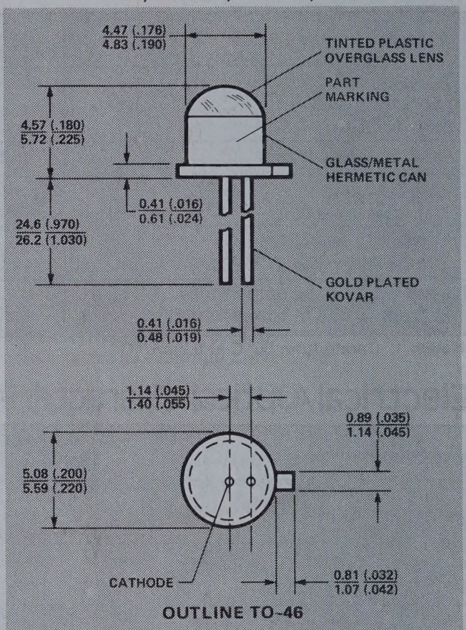
5082-4787, 4687, 4587, 4987


13.21 (.520)
12.70 (.500)
1.78 (.070)
1.52 (.060)
12.7 (.500)
14.8 (.583)
CATHODE
2.67 (.105)
2.41 (.095)
.312-32 UNF-2A (NOTE 3)
CONDUCTIVE SURFACE (ALODINE)
0.64 (.025)
NOMINAL
PART MARKING
9.86 (.388)
9.47 (.373)
CATHODE
3.53 (.139)
3.38 (.133)
0.71 (.028)
0.56 (.022)
0.71 (.028)
0.56 (.022)
2.26
(.089)
9.45 (.372)
10.67 (.420)
10.80
(.425)
.53 (.021)

NOTES:

1. ALL EXTERNAL METAL SURFACES OF THE PACKAGE ARE BLACK ANODIZED EXCEPT FOR THE ALODINE AREA OF THE FLANGE AND THE GOLD PLATED LEADS.
2. MOUNTING HARDWARE WHICH INCLUDES ONE LOCK WASHER AND ONE HEX-NUT IS INCLUDED WITH EACH PANEL MOUNTABLE HERMETIC SOLID STATE LAMP.
3. USE OF METRIC DRILL SIZE 8.20 MILLIMETRES OR ENGLISH DRILL SIZE P (0.323 INCH) IS RECOMMENDED FOR PRODUCING HOLE IN THE PANEL FOR PANEL MOUNTING.
4. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).

1N5765, 1N6092, 1N6093, 1N6094


4.47 (.176)
4.83 (.190)
TINTED PLASTIC OVERGLASS LENS
PART MARKING
4.57 (.180)
5.72 (.225)
GLASS/METAL HERMETIC CAN
0.41 (.016)
0.61 (.024)
24.6 (.970)
26.2 (1.030)
GOLD PLATED KOVAR
0.41 (.016)
0.48 (.019)
1.14 (.045)
1.40 (.055)
0.89 (.035)
1.14 (.045)
5.08 (.200)
5.59 (.220)
CATHODE
0.81 (.032)
1.07 (.042)

**OUTLINE TO-46**

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. GOLD-PLATED LEADS.

# Family of Red 1N5765/5082-4787

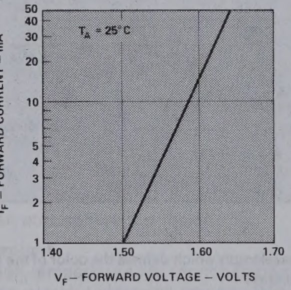


**Figure 2. Forward Current vs. Forward Voltage.**

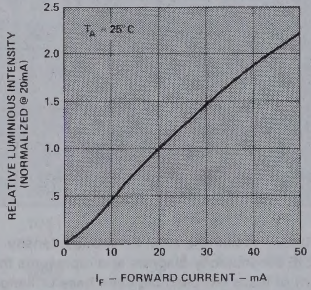


**Figure 3. Relative Luminous Intensity vs. Forward Current.**

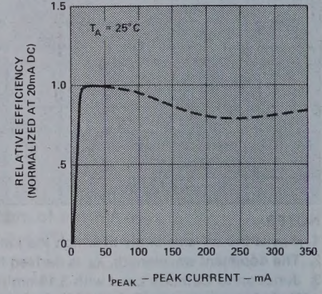


**Figure 4. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.**

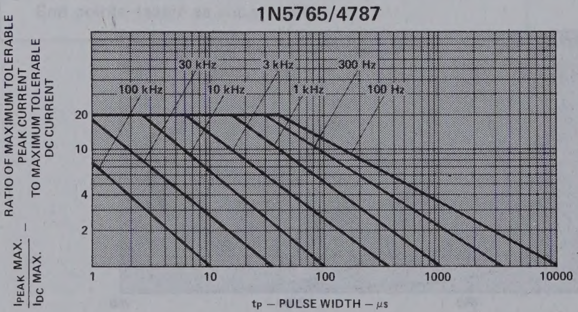


**Figure 5. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

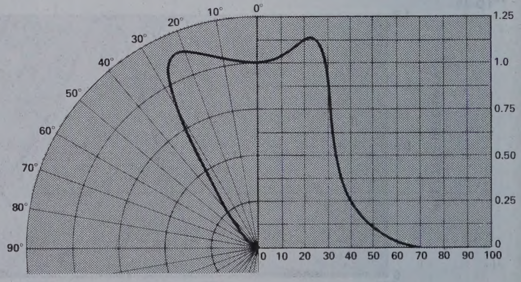


**Figure 6. Relative Luminous Intensity vs. Angular Displacement.**

# Family of High Efficiency Red 1N6092/5082-4687

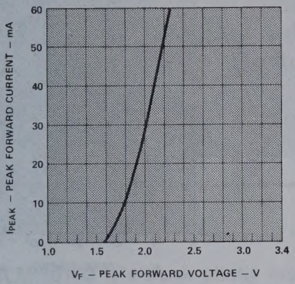


Figure 7. Forward Current vs. Forward Voltage.

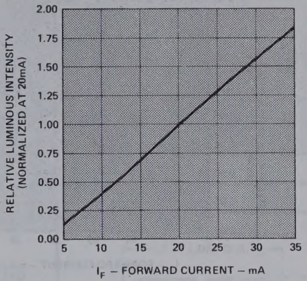


Figure 8. Relative Luminous Intensity vs. Forward Current.

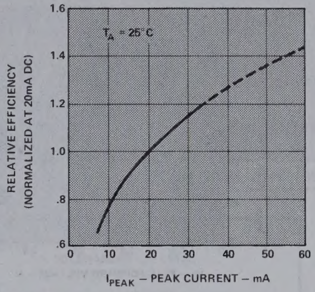


Figure 9. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

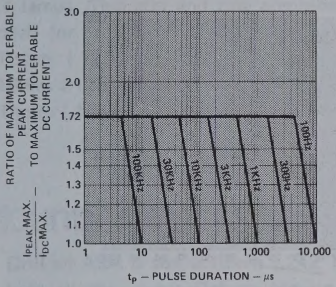


Figure 10. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

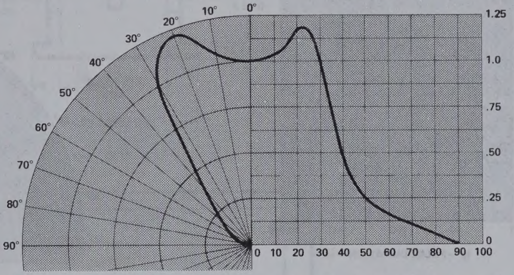


Figure 11. Relative Luminous Intensity vs. Angular Displacement.

# Family of Yellow 1N6093/5082-4587

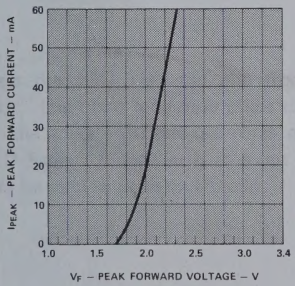


Figure 12. Forward Current vs. Forward Voltage.

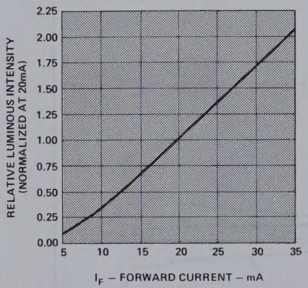


Figure 13. Relative Luminous Intensity vs. Forward Current.

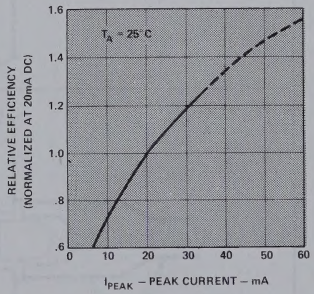


Figure 14. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.

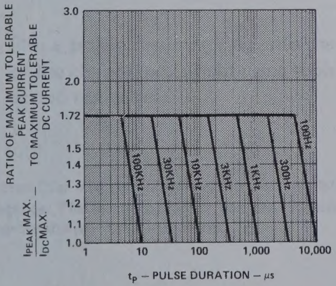


Figure 15. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)

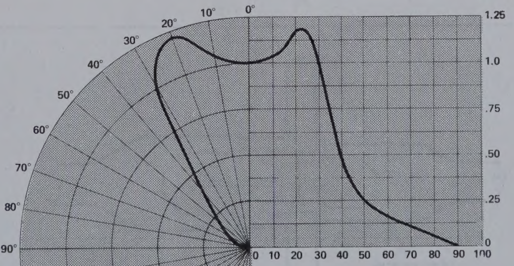


Figure 16. Relative Luminous Intensity vs. Angular Displacement.

# Family of Green 1N6094/5082-4987

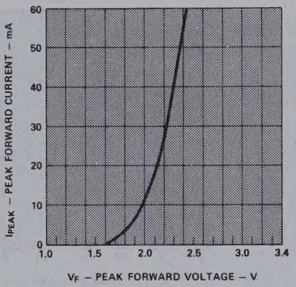


**Figure 17. Forward Current vs. Forward Voltage.**

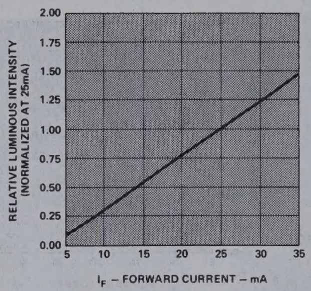


**Figure 18. Relative Luminous Intensity vs. Forward Current.**

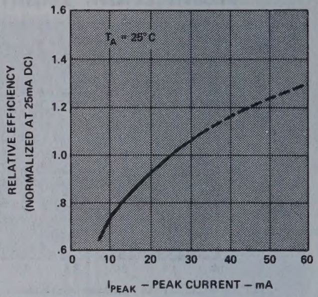


**Figure 19. Relative Efficiency (Luminous Intensity per Unit Current) vs. Peak Current.**

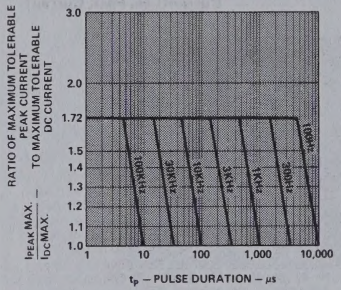


**Figure 20. Maximum Tolerable Peak Current vs. Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

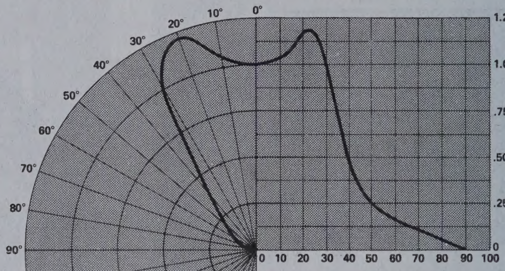


**Figure 21. Relative Luminous Intensity vs. Angular Displacement.**

HEWLETT PACKARD

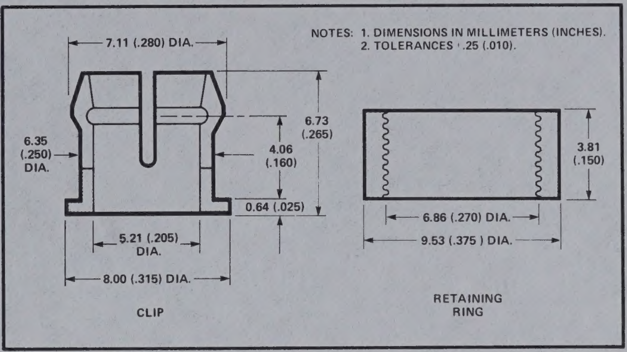
# CLIP AND RETAINING RING FOR PANEL MOUNTED T1 3/4 LEDs

## HLMP-0103 (5082-4707)

TECHNICAL DATA FEBRUARY 1982

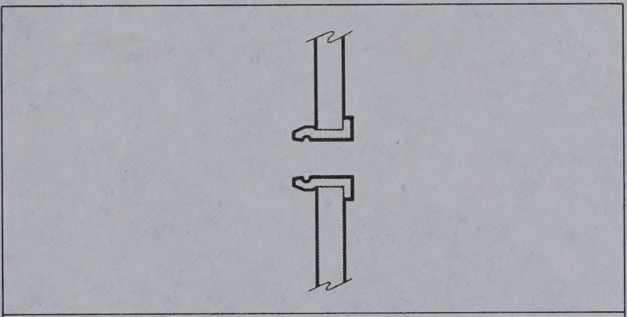
## Description

The HLMP-0103 is a black plastic mounting clip and retaining ring. It is designed to panel mount Hewlett Packard Solid State high profile T - 1¾ size lamps. This clip and ring combination is intended for installation in instrument panels up to 3.18mm (.125") thick. For panels greater than 3.18mm (.125"), counterboring is required to the 3.18mm (.125") thickness.

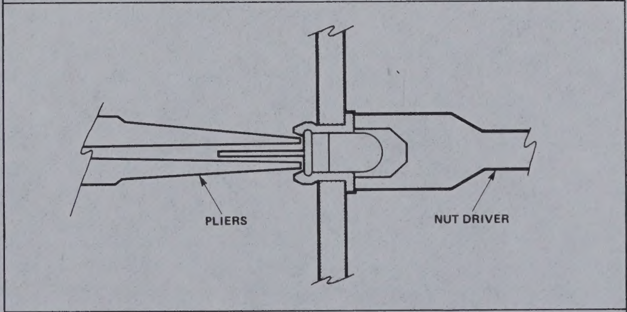

NOTES: 1. DIMENSIONS IN MILLIMETERS (INCHES).
2. TOLERANCES ± .25 (.010).
7.11 (.280) DIA.
6.35 (.250) DIA.
4.06 (.160)
6.73 (.265)
0.64 (.025)
5.21 (.205) DIA.
8.00 (.315) DIA.
CLIP
3.81 (.150)
6.86 (.270) DIA.
9.53 (.375 ) DIA.
RETAINING RING

## Mounting Instructions

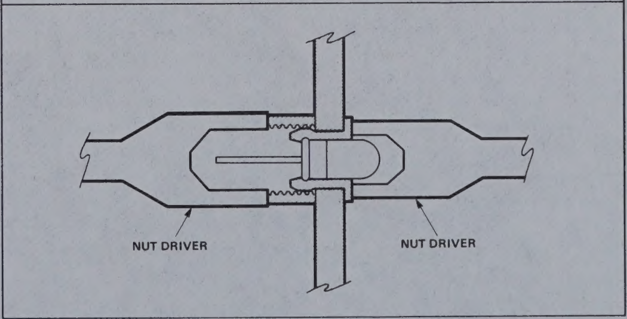
1. Drill an ASA C size 6.15mm (.242") dia. hole in the panel. Deburr but do not chamfer the edges of the hole.
2. Press the panel clip into the hole from the front of the panel.



3. Press the LED into the clip from the back. Use blunt long nose pliers to push on the LED. Do not use force on the LED leads. A tool such as a nut driver may be used to press on the clip.


PLIERS
NUT DRIVER

4. Slip a plastic retaining ring onto the back of the clip and press tight using tools such as two nut drivers.


NUT DRIVER
NUT DRIVER

**Note:** Clip and retaining ring are also available for T-1 package. Please contact your Hewlett-Packard sales representative for information.

# Emitters/Detectors

- Introduction .................. 242
- Selection Guide ............. 243
- Optical Shaft Encoder
- Bar Code Wands
- Bar Code Decoder
- Bar Code Scanner
- Emitters/Detectors

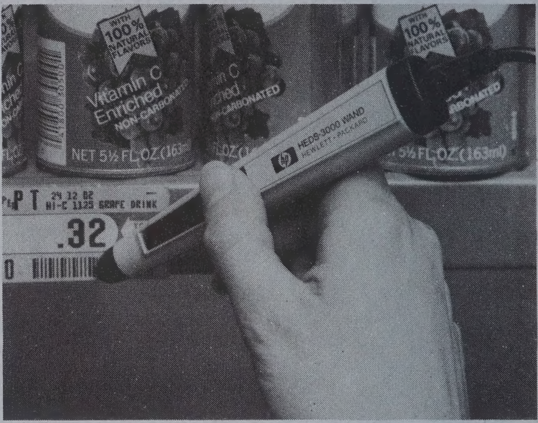
# Bar Code Products

HP has taken years of experience in LED materials technology, bipolar photo IC processing, and precision lens design to develop the HEDS-3000/-3050 Bar Code Wand. The HP Wand is housed in an attractive and rugged plastic case designed to comfortably fit the human hand. The output of the Wand is compatible with standard TTL and CMOS circuitry, thus elminating the need for the designer to provide an analog-to-digital interface within his/her equipment. The performance of the HP Digital Wand is fully specified, allowing the software engineer to optimize the decoding software.

For customers not wishing to invest in decoding technology, HP is developing decoding products as an extension of its bar code product line. The first of these, the HEDS -0100/-0150, is a fully integrated Code 3 of 9 bar code decoder board ideally suited to serve as a slave MPU board to almost any data entry terminal, or as the heart of a small transmit-only terminal. The module, when combined with the HEDS-3050 Bar Code Wand, provides the user with a complete OEM data entry package. This complete package provides a cost effective, high performance solution in applications where extensive investment in bar code decoding software is not warranted.

### Advantages of Bar Code Data Entry

- Faster than key entry
- Greater accuracy due to built-in checksums
- Eliminates the need for trained keyboard operators
- Cost competitive with keyboard systems
- Paper media is both inexpensive and easily reproduceable



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# Optical Shaft Encoders

As an extension of our emitter/detector systems capability, Hewlett-Packard has developed optical shaft encoding systems. HP's optical encoders are motion sensors that provide a digital link converting mechanical shaft rotation into TTL logic level signals. Encoders are used in a wide variety of closed loop servo applications varying from computer peripherals and professional audio-video systems to automated production equipment. Encoders also find widespread usage in industrial and instrument applications where digital information is needed to monitor rotary motion.

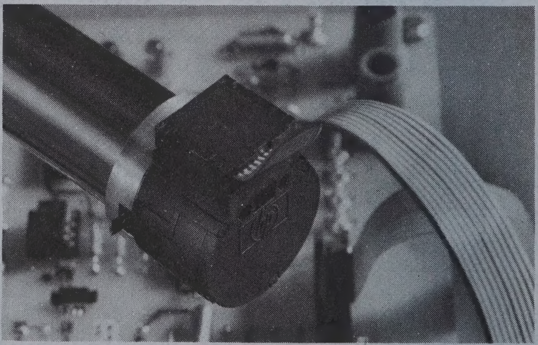
With three easy to assemble components, the HP encoder system takes advantage of a specialized optical design and a custom integrated circuit to deliver superior performance in a compact package. The design also minimizes the mechanical tolerances required of the shaft and mounting surface.

A range of products are available including options for standard shaft sizes and count resolutions ideal for your application.

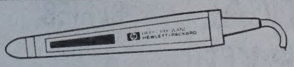
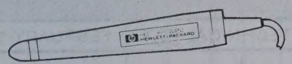
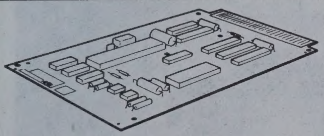
For more information on these new product developments, contact your local Hewlett-Packard Components Field Engineer, or write Hewlett-Packard Optoelectronics Division, 640 Page Mill Rd., Palo Alto, California 94304.

### HP System Features

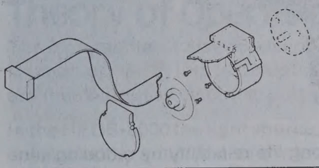
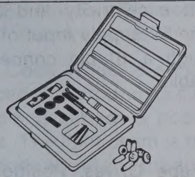
- Fully tested and prealigned components
- 2 digital output channels in quadrature
- Compact package — 28mm diameter
- Fully integrated for high performance and reliability
- LSTTL compatible
- Balanced system compensates for variations i components over time and temperature



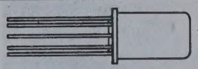
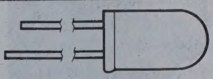
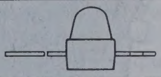
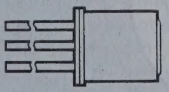
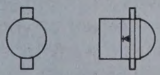
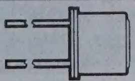
## Bar Code Wands

| Package Outline Drawing | Part No. | Description | Features | Page No. |
|---|---|---|---|---|
|  | HEDS-3000 | Digital Bar Code Wand (With Switch) | • Digital output<br>• Push-to-read switch available for low power applications<br>• Internal shielding available for improved electrical noise rejection<br>• Full line of options available | 254 |
|  | HEDS-3050 | Digital Bar Code Wand (Shielded) | | |
|  | HEDS-0100<br>HEDS-0150 | Bar Code Decoder Module | • Standard PC board designs<br>• Decoder 3 of 9 code<br>• RS-232-C + parallel ASCII interface | 260 |

## Optical Shaft Encoders

| Package Outline Drawing | Part No. | Description | Features | Page No. |
|---|---|---|---|---|
|  | HEDS-5000 | 28 mm Diameter Optical Shaft Encoder | • Small size — 28 mm diameter<br>• 500 cycles/revolution (100-500 available)<br>• 6 standard shaft sizes<br>• Quick assembly — 5 min. typical<br>• 0.25 mm (.010 inches) end play allowance<br>• -20° to 85° C operating range | 244 |
|  | HEDS-8900 | Shaft Encoder Assembly Tools | • One tool set assembles approximately 12 encoders/hr.<br>• The tool kit is packaged in a convenient and rugged carrying case<br>• The tool kit is adaptable to all shaft sizes | 252 |

## Emitter/Detector Components

| Package Outline Drawing | Part No. | Description | Features | Page No. |
|---|---|---|---|---|
|  | HEDS-1000 | High Resolution Optical Reflective Sensor | • Fully specified and guaranteed for assured performance<br>• Visible light source can detect most colors<br>• Photo IC detector optimizes speed and response<br>• Standard T0-5 header | 268 |
|  | HEMT-3300 | 670 nm High Radiant Intensity Emitter | • Visible (near IR) emission facilitates alignment<br>• Compatible with most silicon phototransistors and photodiodes | 274 |
|  | HEMT-6000 | 700 nm High Intensity Subminiature Emitter | | 276 |
|  | 5082-4203<br>5082-4204<br>5082-4207 | 5082-4200 Series PIN Photodiodes | • Low dark current<br>• High responsivity, wide spectral response, with high speed operation<br>• Offset wirebond for optimum use in fiber optic applications | 278 |
|  | 5082-4205 | | | |
|  | 5082-4220 | | | |

**HEWLETT PACKARD**

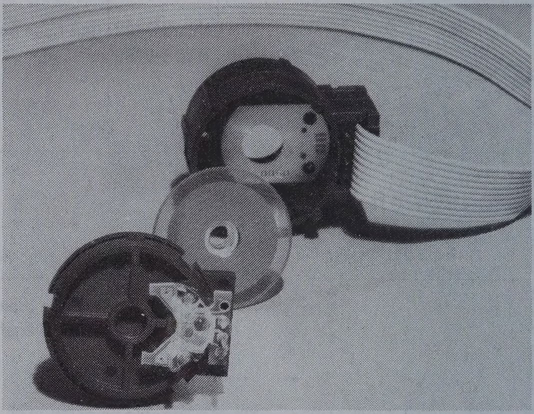
# 28 mm DIAMETER TWO CHANNEL INCREMENTAL OPTICAL ENCODER KIT

## HEDS-5000 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- **SMALL SIZE — 28 mm DIAMETER**
- **500 CYCLES/REVOLUTION**
- **QUICK ASSEMBLY — 5 MIN. TYPICAL**
- **0.25 mm (.010 INCHES) END PLAY ALLOWANCE**
- **LSTTL COMPATIBLE DIGITAL OUTPUT**
- **SINGLE 5V SUPPLY**
- **-20° TO 85° C OPERATING RANGE**
- **SOLID STATE RELIABILITY**



## Description

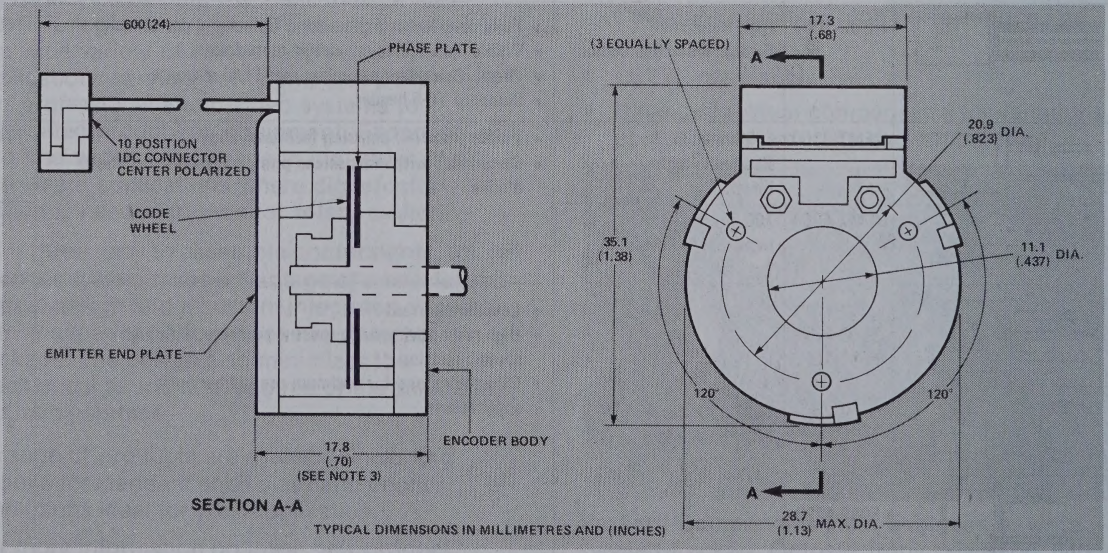
The HEDS-5000 is a high resolution incremental optical encoder kit emphasizing ease of assembly and reliability. The compact 28 mm diameter package consists of 3 parts: the encoder body, a low inertia code wheel, and emitter end plate. An LED source and lens transmit collimated light from the emitter module through a precision metal code wheel and phase plate into a bifurcated detector lens.

The light is focused onto two pairs of closely spaced integrated detectors which output two square wave channels in quadrature. The collimated light and detector configuration increase long life reliability by reducing sensitivity to shaft end play, shaft eccentricity and LED degradation. The outputs and the 5V supply input of the HEDS-5000 are accessed through a 10 pin connector mounted on a .6 metre ribbon cable.

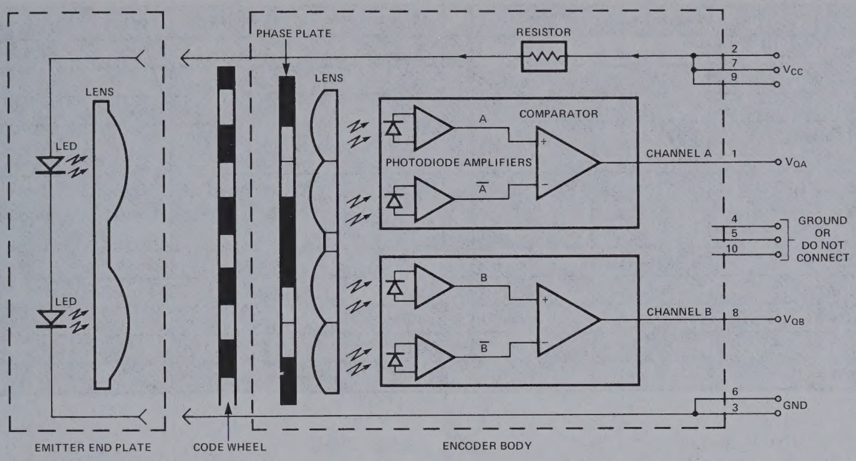
## Applications

Printers, Plotters, Disc and Tape Drives, Positioning Tables, Automatic Handlers, Robots, and any other servo loop where a small high performance encoder is required.

## Outline Drawing


600 (24)
PHASE PLATE
10 POSITION IDC CONNECTOR CENTER POLARIZED
CODE WHEEL
EMITTER END PLATE
ENCODER BODY
17.8 (.70) (SEE NOTE 3)
SECTION A-A
TYPICAL DIMENSIONS IN MILLIMETRES AND (INCHES)
17.3 (.68)
(3 EQUALLY SPACED)
A
20.9 (.823) DIA.
35.1 (1.38)
11.1 (.437) DIA.
120°
120°
A
28.7 (1.13) MAX. DIA.

# Block Diagram



# Theory of Operation

The incremental shaft encoder operates by translating the rotation of a shaft into interruptions of a light beam which are then output as electrical pulses.

In the HEDS-5000 the light source is a Light Emitting Diode collimated by a molded lens into a parallel beam of light. The Emitter End Plate contains two similar light sources, one for each channel.

The Code Wheel is a metal disc which has 500 equally spaced slits around its circumference. An aperture with a matching pattern is positioned on the stationary phase plate. The light beam is transmitted only when the slits in the code wheel and the aperture line up; therefore, during a complete shaft revolution, there will be 500 alternating light and dark periods. A molded lens beneath the phase plate aperture collects the modulated light into a silicon detector.

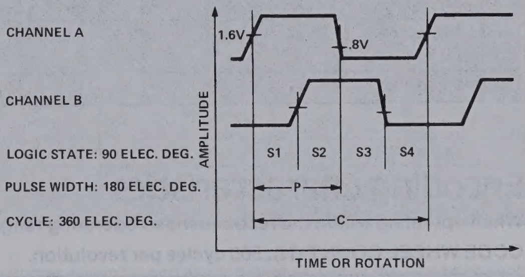
The Encoder Body contains the phase plate and the detection elements for two channels. Each channel consists of an integrated circuit with two photodiodes and amplifiers, a comparator and output circuitry.

The apertures for the two photodiodes are positioned so that a light period on one detector corresponds to a dark period on the other. The photodiode signals are amplified and fed to the comparator whose output changes state when the relative magnitude of the two photo currents changes sign ("Push-Pull"). The second channel has a similar configuration but the location of its aperture pair provides an output which is in quadrature to the first channel (phase difference of 90°). Direction of rotation is determined by observing which of the channels is the leading waveform. The outputs are logic level signals capable of driving one LSTTL load.

The three part kit is assembled by attaching the Encoder Body to the mounting surface using three screws. The Code Wheel is set to the correct gap and epoxied on the shaft. Snapping the cover (Emitter End Plate) on the body completes the assembly. The only adjustment necessary is the encoder centering relative to the shaft, to optimize quadrature.

# Output Waveforms & Definitions

(FOR COUNTER CLOCKWISE ROTATION OF CODE WHEEL AS VIEWED FROM EMITTER END PLATE)



Electrical degrees:
1 shaft rotation = 360 angular degrees
= 500 cycles
1 cycle = 360 electrical degrees

Position Error:

For any starting transition, the maximum discrepancy between actual shaft position and position calculated by counting the encoder's cycles.

Cycle Error:

An indication of cycle uniformity. The difference between an observed shaft angle which gives rise to one electrical cycle, and the nominal angular increment of 1/500 of a revolution.

Phase:

The angle between the center of Pulse A and the center of Pulse B.

## Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Units | Notes |
|---|---|---|---|---|---|
| Storage Temperature | $T_S$ | -55 | 100 | ° Celsius | |
| Operating Temperature | $T_A$ | -55 | 85 | ° Celsius | |
| Vibration | | | 20 | g | See Note #2 |
| Shaft Axial Play | | | 0.5 (20) | mm($\frac{1}{1000}$ in) TIR | |
| Shaft Eccentricity Plus Radial Play | | | 0.1 (4) | mm($\frac{1}{1000}$ in) TIR | Movement should be limited even under shock conditions. |
| Supply Voltage | $V_{CC}$ | -0.5 | 7 | Volts | |
| Output Voltage | $V_O$ | -0.5 | $V_{CC}$ | Volts | |
| Output Current | $I_O$ | -1 | 5 | mA | |
| Velocity | | | 30,000 | R.P.M. | |
| Acceleration | $\alpha$ | | 250,000 | Rad. Sec$^{-2}$ | |

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units | Notes |
|---|---|---|---|---|---|
| Temperature | T | -20 | 85 | ° Celsius | Non-condensing atmos. |
| Supply Voltage | $V_{CC}$ | 4.5 | 5.5 | Volt | Ripple < 100mV$_{p-p}$ |
| Code Wheel Gap | | | 0.8 (32) | mm (inch/1000) | Nominal gap = 0.43 mm (.017 in.) when shaft is at minimum gap position. |
| Shaft Perpendicularity Plus Axial Play | | | 0.25 (10) | mm (inch/1000) TIR | |
| Shaft Eccentricity Plus Radial Play | | | 0.04 (1.5) | mm (inch/1000) TIR | 10 mm (0.4 inch) from mounting surface. |
| Load Capacitance | $C_L$ | | 100 | pF | |

## Encoding Characteristics

When operating within the recommended operating range unless otherwise specified. f < 25 kHz

CODE WHEEL COUNT (N): 500 cycles per revolution.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Notes (See Definitions) |
|---|---|---|---|---|---|---|
| Position Error | $\Delta\Theta$ | | 10 | 40 | Minutes of Arc | 1 Cycle = 43.2 Minutes<br>See Figure 1. |
| Cycle Error | $\Delta C$ | | 3 | 10 | Electrical deg. | |
| Max. Count Frequency | $f_{MAX}$ | 100,000 | 200,000 | | Hertz | f = Velocity (RPM) x N/60 |
| Pulse Width Error | $\Delta P$ | | 20 | | Electrical deg. | T = 25° C. See Note 1. |
| Pulse Width Temp. Coefficient | $\alpha$ | | $1.0 \times 10^{-5}$ | $2.5 \times 10^{-5}$ | Electrical deg. (°C x Hz) | $\Delta P = \alpha \times \Delta T \times f$<br>See Figure 2. |
| Phase Sensitivity to Eccentricity | | | 550<br>(14) | | Elec. deg./mm<br>(Elec. deg./mil) | mil = inch/1000 |
| Phase Sensitivity to Axial Play | | | 20<br>(.5) | | Elec. deg./mm<br>(Elec. deg./mil) | mil = inch/1000 |
| Logic State Width Error | $\Delta S$ | | 30 | | Electrical deg. | T = 25° C. See Note 1. |
| State Width Temp. Coefficient | $\|\alpha\|$ | | $1.0 \times 10^{-5}$ | $2.5 \times 10^{-5}$ | Electrical deg. (°C x Hz) | $\Delta S = \alpha \times \Delta T \times f$<br>See Figure 2. |

## Mechanical Characteristics

| Parameter | Symbol | Dimension | Tolerance | Units | Notes |
|---|---|---|---|---|---|
| Outline Dimensions | | See Mech. Dwg. | | | |
| Code Wheel Available to Fit the Following Standard Shaft Diameters | | 2<br>3<br>1/8<br>3/16<br>5/32<br>1/4 | +0.00, -0.015<br>+0.00, -0.015<br>+0.000, -0.0007<br>+0.000, -0.0007<br>+0.0002, -0.0005<br>+0.000, -0.0007 | mm<br>mm<br>inches<br>inches<br>inches<br>inches | |
| Moment of Inertia | J | 0.4 (6*10$^{-6}$) | | gcm$^2$ (oz-in-s$^2$) | |
| Required Shaft Length | | 12.8 (.50) | ±0.5 (±0.02) | mm (inches) | See Dwg. 7. Shaft at minimum length position. |
| Bolt Circle | | 20.9 (.823) | ±0.13 (±.005) | mm (inches) | See Dwg. 7 |
| Screw Size | | 1.6 x 0.35 x 5mm DIN 84<br>or<br>0-80 x 3/16 Binding Head | | mm<br>inches | |

## Electrical Characteristics

When operating within the recommended operating range.

Electrical Characteristics over Recommended Operating Range (Typical at 25°C).

| Parameter | Symbol | Min. | Typ. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Supply Current | $I_{CC}$ | | 19 | 40 | mA | |
| High Level Output Voltage | $V_{OH}$ | 2.4 | | | V | $I_{OH} = -40\mu A$ Max. |
| Low Level Output Voltage | $V_{OL}$ | | | 0.5 | V | $I_{OL} = 0.4$ mA (one LSTTL load) |
| Rise Time | $t_r$ | | 0.5 | | μs | $C_L = 25$ pF, $R_L = 11$ K |
| Fall Time | $t_f$ | | 0.2 | | μs | $C_L = 25$ pF, $R_L = 11$ K |
| Cable Capacitance | $C_{CO}$ | | 12 | | pF/meter | Output Lead to Ground |

**NOTES:**

1. The pulse width and state width errors will be determined by the customer assembly and environment as well as the kit components. In a properly assembled lot operated within the recommended operating range more than 95% of the units are expected to exhibit a pulse width error below 60 degrees, and a state width error below 70 degrees. At room temperature the corresponding errors are expected to be between 35 and 45 degrees.
2. The structural parts of the HEDS-5000 have been successfully tested to 20g. In a high vibration environment use is limited at low frequencies (high displacement) by cable fatigue and at high frequencies by code wheel resonances. Resonant frequency depends on code wheel material and number of counts per revolution. Consult factory for further information. See Application Note 1011 for suggestions on securing cable.
3. The typical length of an assembled HEDS-5000 encoder is 17.8 (.70 inch). However, it is recommended that room be left to accomodate a length of 21.6 (.85 inch). Future developments may result in an enhanced version of the HEDS-5000 encoder that is slightly longer.

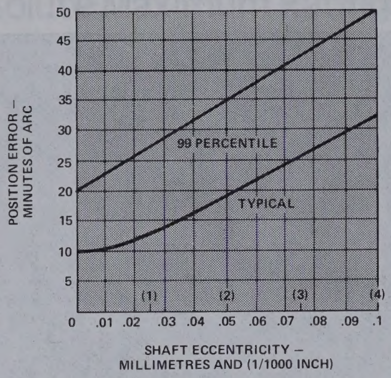


**Figure 1. Position Error vs. Shaft Eccentricity**

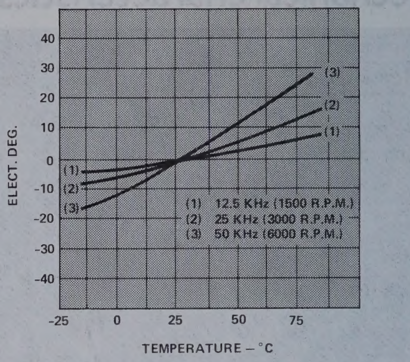


**Figure 2. Typical Pulse Width Change vs. Temperature**

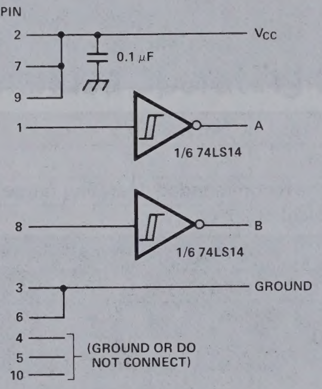
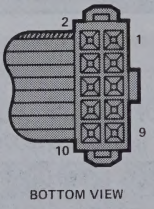

PIN
2
7
9
1
8
3
6
4
5
10
Vcc
0.1 μF
A
1/6 74LS14
B
1/6 74LS14
GROUND
(GROUND OR DO NOT CONNECT)

**Figure 3. Recommended Interface Circuit**


2
1
10
9
BOTTOM VIEW

PINOUT

| PIN # | FUNCTION |
|---|---|
| 1 | CHANNEL A |
| 2 | $V_{CC}$ |
| 3 | GROUND |
| 4 | N.C. OR GROUND |
| 5 | N.C. OR GROUND |
| 6 | GROUND |
| 7 | $V_{CC}$ |
| 8 | CHANNEL B |
| 9 | $V_{CC}$ |
| 10 | N.C. OR GROUND |

MATING CONNECTOR
BERG 65-692-001 OR EQUIVALENT

**Figure 4. Connector Specifications**

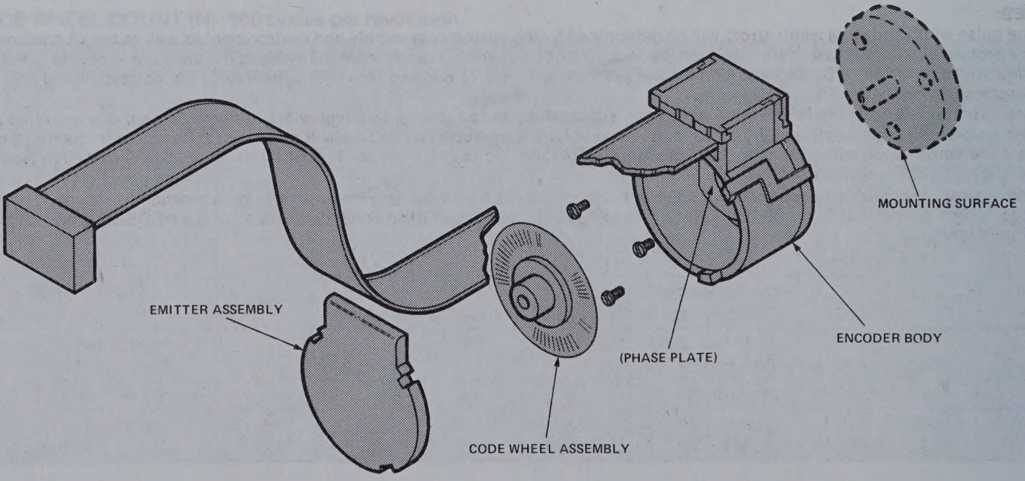

MOUNTING SURFACE
EMITTER ASSEMBLY
(PHASE PLATE)
ENCODER BODY
CODE WHEEL ASSEMBLY

**Figure 5. HEDS-5000 Encoder Kit**

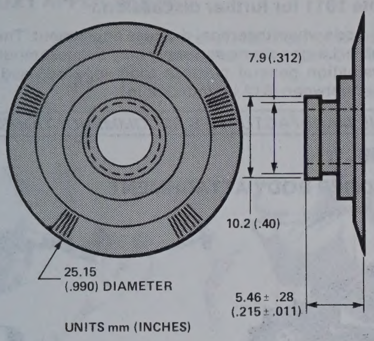

7.9 (.312)
10.2 (.40)
25.15
(.990) DIAMETER
5.46 ± .28
(.215 ± .011)
UNITS mm (INCHES)

Figure 6. Code Wheel

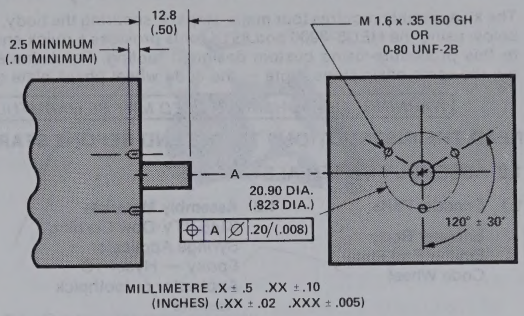

12.8
(.50)
2.5 MINIMUM
(.10 MINIMUM)
M 1.6 x .35 150 GH
OR
0-80 UNF-2B
A
20.90 DIA.
(.823 DIA.)
⌖ A ⌀ .20/(.008)
120° ± 30'
MILLIMETRE .X ± .5 .XX ± .10
(INCHES) (.XX ± .02 .XXX ± .005)

Figure 7. Mounting Requirements

# Ordering Information

**ENCODER**

HEDS-5[ ]00

OPT A0[ ]

| [ ] | DESCRIPTION |
|---|---|
| 0 | COMPLETE KIT |
| 1 | CODE WHEEL |
| 2 | ENCODER BODY |
| 3 | EMITTER END PLATE |

**ASSEMBLY TOOLING**

TOOL KIT : HEDS-8900
GAP AND CENTERING SET : HEDS-891[ ]
CODE WHEEL EXTRACTOR : HEDS-8920
PROBE ASSEMBLY : HEDS-8921

| [ ] | SHAFT DIAMETER |
|---|---|
| 0 | ENCODER BODY<br>EMITTER END PLATE |
| 1 | 2 mm |
| 2 | 3 mm |
| 3 | 1/8 INCH |
| 4 | 5/32 INCH |
| 5 | 3/16 INCH |
| 6 | 1/4 INCH |

**Example:**

a. An encoder kit to be mounted on a 1/4″ shaft should be ordered as: HEDS-5000
OPT A06

b. To order a complete set of assembly tools two items should be specified:
1. HEDS-8900 tool kit
2. HEDS-891X gap and centering set (for the 1/4″ shaft HEDS-8916).

See tool kit data sheet for details.

**Ordering Encoder Pieceparts:**

a. Code Wheels — use option code
e.g.: HEDS-5100
OPT A0X where X relates to shaft diameter

b. Encoder Bodies — use option code A00
e.g.: HEDS-5200
OPT A00

c. Encoder End Plates — no option code
e.g.: HEDS-5300

# Shaft Encoder Kit Assembly **See Application Note 1011 for further discussion.**

The kit assembly requires four major steps: a. securing the body, b. gap setting, c. code wheel insertion, d. phase adjustment. The method below using the HEDS-8900 and 891X tools provides a quick and reliable assembly. Large volume assembly may suggest modifications to this procedure using custom designed tooling. For a limited prototype evaluation general purpose tools may be used to carry out the same basic steps. Note — the code wheel phase plate gap should be set between .012 in and .022 in.

*WARNING: THE ADHESIVES USED MAY BE HARMFUL. CONSULT THE MANUFACTURER'S RECOMMENDATIONS.*

**READ THE INSTRUCTIONS TO THE END BEFORE STARTING ASSEMBLY.**

## 1.0 ASSEMBLY MATERIALS

### 1.1 Encoder Parts

Encoder Body
Emitter End Plate
Code Wheel

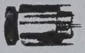
### 1.2 Assembly Materials

3145 RTV-Dow Corning
Syringe Applicator
Epoxy — Hysol 1C
Applicator or toothpick
Acetone

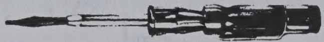
### 1.3 Assembly Tools

HEDS-8900 Tool Kit or equivalent
(Data Sheet available)

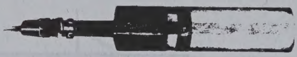
PROBE ASSEMBLY



CODE WHEEL EXTRACTOR

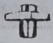


HOLDING SCREW DRIVER

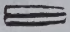


TORQUE LIMITING SCREW DRIVER

HEDS-891X Gap and Centering Set
(Data Sheet available)

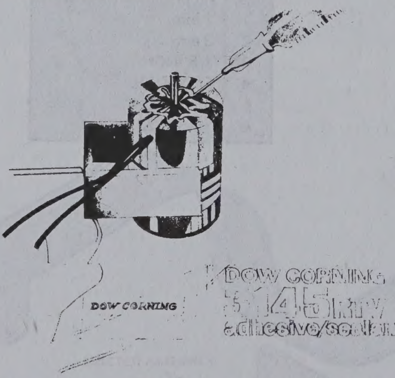


GAP HUB



CENTERING CONE

## 2.0 SURFACE PREPARATION



THE ELAPSED TIME BETWEEN THIS STEP AND STEP 8 SHOULD NOT EXCEED 1/2 HOUR.

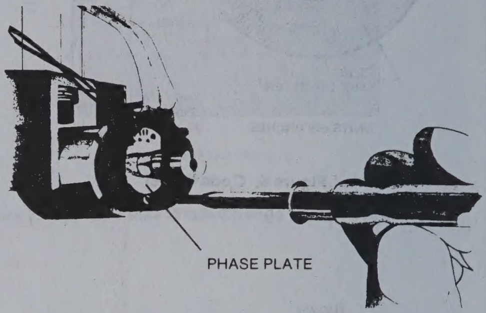
2.1 Clean and degrease with acetone the mounting surface and shaft.

2.2 Load the syringe with RTV.

2.3 Apply RTV into screw threads on mounting surface. Apply more RTV on the surface by forming a daisy ring pattern connecting the screw holes.

*CAUTION: KEEP RTV AWAY FROM THE SHAFT BEARING.*

## 3.0 ENCODER BODY ATTACHMENT



3.1 Hold the encoder body on the mounting surface. Slip the centering tool (taper down) over the shaft and align the encoder until the centering tool drops into the phase plate center hole.

3.2 Place a screw in the holding screw driver. Insert the screw through a hole in the body and start the threading.

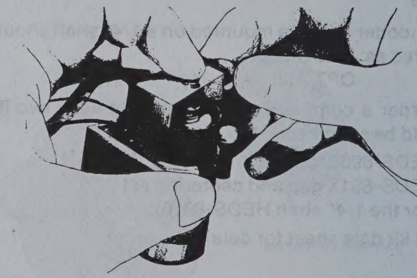
*DO NOT TIGHTEN AT THIS TIME!*

3.3 Thread the other two screws without tightening.

3.4 Using the torque limiting screw driver, tighten the screws to 0.5 cm· kg (7.0 in-oz). See notes 3 and 4.

3.5 Remove centering tool.

## 4.0 CODE WHEEL GAP SETTING



4.1 Slip the gap hub over the shaft (longer sleeve first) until it rests on the phase plate surface.

4.2 Loosen the thumb screw on the probe assembly. Place the probe assembly on the encoder body rim. The extended ribs on the encoder body should fit into the slots in the probe assembly.

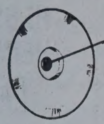
4.3 Let the probe rest squarely on the dummy code wheel. Apply light pressure with your index finger on the probe's upper shaft and tighten the thumb screw.

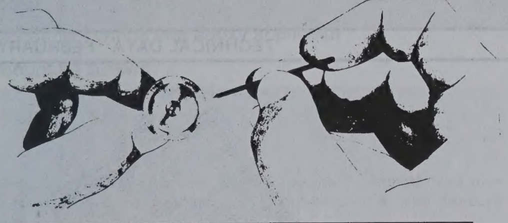
4.4 Remove probe assembly and dummy code wheel.

*THE PROBE ASSEMBLY IS NOW SET FOR THE PROPER GAP.*

*DO NOT LOOSEN THE THUMB SCREW UNTIL ASSEMBLY IS COMPLETED.*

## 5.0 EPOXY APPLICATION


EVEN DISTRIBUTION OF EPOXY AROUND LOWER PART OF INTERIOR HUB BASE



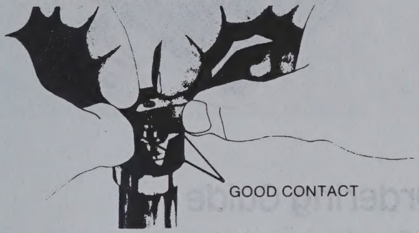
*CAUTION: HANDLE THE CODE WHEEL WITH CARE.*

5.1 Collect a small dab of epoxy on a toothpick tip.

5.2 Spread the epoxy inside the lower part of the hub bore.

5.3 Holding the code wheel by its hub, slide it down the shaft just enough to sit it squarely. About 3 mm (1/8").

## 6.0 CODE WHEEL INSERTION



6.1 Take up any loose play by lightly pulling down on the shaft's load end.

6.2 Place the preset probe assembly over the code wheel and push down.

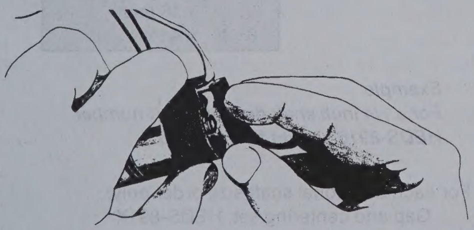
6.3 Check that the probe assembly is seated squarely on the body rim and maintains contact with the code wheel hub.

6.4 No epoxy should extrude through the shaft hole.

*DO NOT TOUCH THE CODE WHEEL AFTER ASSEMBLY.*

*See Note 5*

## 7.0 EMITTER END PLATE



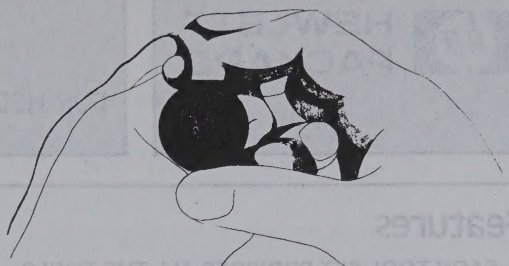
7.1 Apply a narrow bead of RTV on the peripheral groove of the emitter end plate inner face.

7.2 Visually check that the two wire leads on the encoder body are straight.

7.3 Hold the end plate parallel to the encoder body rim. Align the guiding pin on the end plate with the hole in the encoder body and press the end plate straight down until it is locked into place.

7.4 Visually check that the end plate is properly seated (especially near the cable end).

## 8.0 PHASE ADJUSTMENT



8.1 Connect the encoder cable.

8.2 Run the motor and using either the scope presentation or a phase meter reading, adjust for minimum phase error by sliding the encoder on its mounting surface backward or forward as shown by the arrow.

8.3 Handle the encoder with care until the epoxy has cured. Cure time: 24 hours at room temperature, 2 hours at 60° C.
See Application Note 1011 for Phase Meter Schematic.

## 9.0 CODE WHEEL REMOVAL

In the event that the code wheel has to be removed after the epoxy has set, use the code wheel extractor as follows:

9.1 Remove the emitter end plate by prying a screw driver in the slots provided around the encoder body rim. Avoid bending the wire leads.

9.2 Turn the screw on the extractor counter-clockwise until the screw tip is no longer visible.

9.3 Slide the extractor's horseshoe shaped lip all the way into the groove on the code wheel's hub.

9.4 While holding the extractor body stationary, turn the thumb screw clockwise until the screw tip pushes against the shaft.

9.5 Applying more turning pressure will pull the hub upwards breaking the epoxy bond.

9.6 Clean the shaft before reassembly.

*INSPECT THE PHASE PLATE FOR DAMAGE OR DEBRIS.*

**NOTES:**

3. At this torque value, the encoder should slide on its mounting surface but only with considerable thumb pressure.
4. The torque limiting screw driver supplied with the tool kit is set to the specified torque but may require periodic calibration.
5. If the code wheel has been moved, remove the code wheel, wipe the shaft, and restart at step 1 under Epoxy Application (5.1).

HEWLETT PACKARD

# SHAFT ENCODER ASSEMBLY TOOLS

## FOR HEDS-5000 SERIES ENCODERS

## HEDS-8900
## HEDS-891X
## SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- EACH TOOL SET PROVIDES ALL THE TOOLS NECESSARY FOR EASY AND RELIABLE ASSEMBLY OF THE HEDS-5000 ENCODER
- ONE TOOL SET ASSEMBLES APPROXIMATELY 12 ENCODERS/HR
- THE TOOL KIT IS PACKAGED IN A CONVENIENT AND RUGGED CARRYING CASE
- THE TOOL KIT IS ADAPTABLE TO ALL SHAFT SIZES
- INDIVIDUAL TOOLS AVAILABLE FOR MULTIPLE ASSEMBLY STATIONS

## Description

The HEDS-8900 tool kit and the appropriate gap and centering set provide all the tools necessary to easily and reliably assemble HEDS-5000 encoder kits.

In a convenient carrying case, the tool kit contains all the assembly tools which are independent of shaft diameter.

Spaces in the foam insert are provided for your selection of the HEDS-891X gap and centering tools, suitable to your shaft diameter. The HEDS-8920 code wheel extractor and HEDS-8921 probe assembly included in the 8900 kit, can also be purchased as individual items.

Please see the ordering guide for part number and shaft size information.

## Parts List

**HEDS-8900 Tool Kit (for all hub sizes)**

| | |
|---|---|
| 1 | Torque limiting screwdriver (set at 7 lb/in) |
| 1 | Holding screwdriver |
| 1 | Probe assembly (HEDS-8921) |
| 1 | Code wheel extractor (HEDS-8920) |
| 1 | Carrying case |

**HEDS-891X Gap and Centering Set**

| | |
|---|---|
| 1 | Centering cone |
| 1 | Gap hub |

Note: I.D. is specific to hub size selected

**HEDS-8920**

1 Code wheel extractor (for all hub sizes)

**HEDS-8921**

1 Probe assembly (for all hub sizes)

## Ordering Guide

1. To order a complete set of assembly tools two items should be specified:
   - a) Tool kit: HEDS-8900
   - b) Gap and centering set: HEDS-891X

| X | Shaft Diameter |
|---|---|
| 0 | N.A. |
| 1 | 2 mm |
| 2 | 3 mm |
| 3 | 1/8 inch |
| 4 | 5/32 inch |
| 5 | 3/16 inch |
| 6 | 1/4 inch |

*Example:*
*For a 1/4 inch shaft diameter part number HEDS-8916 should be specified.*

2. For each additional shaft size order only: Gap and centering set: HEDS-891X

3. The following items may be ordered individually:
   - a) Gap and centering set: HEDS-891X (as above)
   - b) Code wheel extractor: HEDS 8920
   - c) Probe assembly: HEDS-8921

# Consumable Materials

Some additional materials, not supplied by H.P., are necessary to complete an encoder assembly:

Acetone or another degreasing agent
*RTV — Dow Corning 3145 or GE 162
*Epoxy — Hysol 1C

Disposable syringe and epoxy applicator

3 mounting screws
  1.6 x 0.35 x 5mm DIN 84 or
  0-80 x 3/16 Binding Head

*These adhesives were chosen for their viscosity, strength, and non-corrosive properties. Substitutes should not be used without thorough testing and qualification.

HEWLETT PACKARD

# DIGITAL BAR CODE WAND

# HEDS-3000 HEDS-3050

TECHNICAL DATA FEBRUARY 1982

## Features

- **0.3 mm RESOLUTION**
  **Enhances the Readability of dot matrix printed bar codes**
- **DIGITAL OUTPUT**
  **Open Collector Output Compatible with TTL and CMOS**
- **PUSH-TO-READ SWITCH (HEDS-3000)**
  **Minimizes Power in Battery Operated Systems**
- **SINGLE SUPPLY OPERATION**
- **ATTRACTIVE, HUMAN ENGINEERED CASE**
- **DURABLE LOW FRICTION TIP**
- **SOLID STATE RELIABILITY**
  **Uses LED and IC Technology**
- **SHIELDED CASE AND CABLE (HEDS-3050)**
  **Minimizes EMI/ESD Susceptability in AC Powered Systems**

## Description

The HEDS-3000 and HEDS-3050 Digital Bar Code Wands are hand held scanners designed to read all common bar code formats that have the narrowest bars printed with a nominal width of 0.3 mm (0.012 in.). The wands contain an optical sensor with a 700 nm visible light source, photo IC detector, and precision aspheric optics. Internal signal conditioning circuitry converts the optical information into a logic level pulse width representation of the bars and spaces.

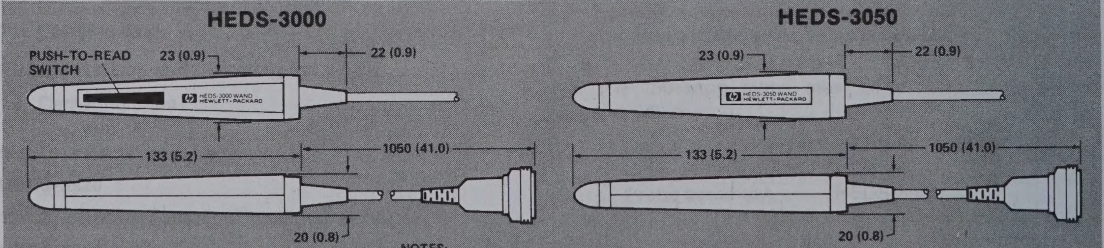
The HEDS-3000 comes equipped with a push-to-read switch which is used to activate the electronics in battery powered applications requiring lowest power consumption. The HEDS-3050 does not have a switch, and features internal metal shielding that minimizes susceptability to electromagnetic interference, electrostatic discharge, and ground loops in AC powered systems. Both wands feature a strain relieved 104 cm (41 in.) cord with a nine-pin subminiature D-style connector.

## Applications

The Digital Bar Code Wand is an effective alternative to the keyboard when used to collect information in self-contained blocks. Bar code scanning is faster than key entry and also more accurate since most codes have check-sums built-in to prevent incorrect reads from being entered.

Applications include remote data collection, ticket identification systems, security checkpoint verification, file folder tracking, inventory control, identifying assemblies in service, repair, and manufacturing environments, and programming appliances, intelligent instruments and personal computers.

## Wand Dimensions



NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES)
2. WEIGHT: NET 46.5g (1.5oz.) SHIPPING 171g (5.5oz.)

## Electrical Operation

The HEDS-3000 and HEDS-3050 consist of a precision optical sensor, an analog amplifier, a digitizing circuit, and an output transistor. These elements provide a TTL compatible output from a single voltage supply range of 3.6V to 5.75V. A non-reflecting black bar results in a logic high (1) level, while a reflecting white space will cause a logic low (0) at the $V_O$ connection (pin 2). The output of the wands is an open collector transistor.

The HEDS-3050 provides a case and cable shield (pin 5) which must be connected to logic ground and preferably also to earth ground. This will provide a substantial reduction in EMI/ESD susceptability for the wand in AC powered systems.

The recommended logic interface for the wands is shown in Figure 3. This interconnection provides maximum ESD protection for both the wand and the user's electronics.

The HEDS-3000 incorporates a push-to-read switch which is used to energize the 700nm LED emitter and electronic circuitry. When the switch is initially depressed, its contact bounce may cause a series of random pulses to appear at the output, $V_O$. This pulse train will typically settle to a final value within 0.5 ms. This initial pulse train is eliminated when a switchless HEDS-3050 is used.

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Bar Width | s, b | 0.3 | | mm |
| Scan Velocity | $V_{scan}$ | 7.6 | 76 | cm/s |
| Contrast | PCS | 70 | | % |
| Supply Voltage | $V_S$ | 3.6 | 5.75 | V |
| Temperature | $T_A$ | 0 | 55 | °C |
| Orientation | See Figure 1 | | | |

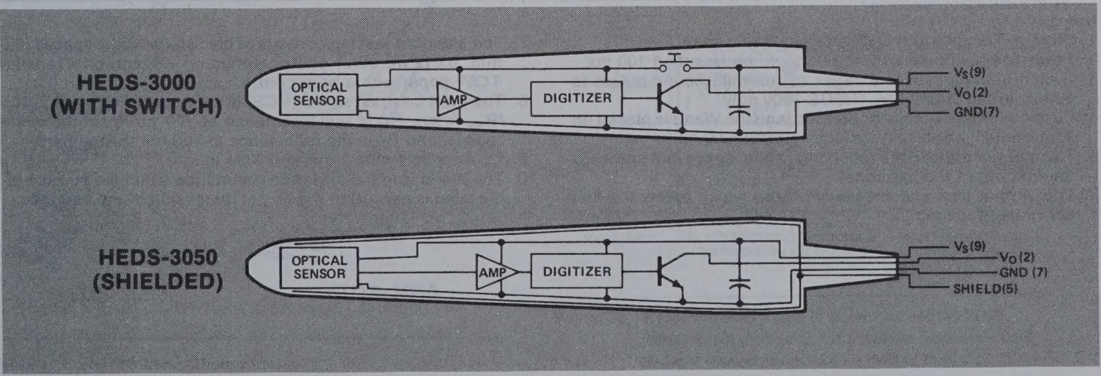
## Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Units | Notes |
|---|---|---|---|---|---|
| Storage Temperature | $T_S$ | -20 | 55 | °C | 1 |
| Operating Temperature | $T_A$ | 0 | 55 | °C | |
| Supply Voltage | $V_S$ | -0.5 | 6.0 | V | 2 |
| Output Transistor Power | $P_T$ | | 200 | mW | |
| Output Collector Voltage | $V_O$ | | 20 | V | |

## Electrical Characteristics ($V_S$ = 3.6V to 5.75V at $T_A$ = 25°C, $R_L$ = 2.2kΩ, unless otherwise noted)

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Fig. | Notes |
|---|---|---|---|---|---|---|---|---|
| Switch Bounce (HEDS-3000) | $t_{sb}$ | | 0.5 | 5 | ms | | | 3 |
| High Level Output Current | $I_{OH}$ | | | -400 | μA | $V_{OH}$ = 2.4V, Bar Condition (Black) | 3 | |
| Low Level Output Voltage | $V_{OL}$ | | | 0.4 | V | $I_{OL}$ = 16mA, Space Condition (White) | 3 | |
| Output Rise Time | $t_r$ | | 2 | | μs | 10%-90% Transition | 3 | |
| Output Fall Time | $t_f$ | | 2 | | μs | 90%-10% Transition | 3 | |
| Supply Current | $I_S$ | | | 50 | mA | $V_S$ = 5V, Bar Condition (Black) | | 2,4 |

## Block Diagram



## GUARANTEED WIDTH ERROR PERFORMANCE

($V_S$ = 5V, $T_A$ = 0° C to 55° C, $R_L$ = 2.2kΩ, unless otherwise noted)

| Parameter | | Symbol | Min. | Typ. | Max. | Units | Conditions | | Fig. | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| Bar Width Error | 1st | $\Delta b_1$ | | 0.08 (3.2) | 0.13 (5.2) | mm (in.x$10^{-3}$) | $T_A$=25° C | Margin ≥ 5mm<br>Height = 0.25mm<br>Tilt = 0°<br>$v_{scan}$ = 50 cm/s<br>Standard Test Tag<br>Preferred Orientation<br>b=s=0.3mm (0.012 in.)<br>2b=2s=0.6mm (0.024 in.) | 1<br>2,6<br>11 | 5<br>7,8<br>9,10<br>11 |
| | | | | 0.10 (3.8) | 0.15 (5.7) | | $T_A$ = 0° to 55° C | | | |
| | Interior | $\Delta b$ | -0.04 (-1.4) | 0.05 (1.8) | 0.10 (3.9) | mm (in.x$10^{-3}$) | $T_A$=25° C | | 1,2<br>6,11 | 6,7<br>8,9<br>10,11 |
| | | | -0.05 (-2.0) | 0.05 (2.0) | 0.11 (4.3) | | $T_A$ = 0° to 55° C | | | |
| Space Width Error | Interior | $\Delta s$ | 0.04 (1.4) | -0.05 (-1.8) | -0.10 (-3.9) | mm (in.x$10^{-3}$) | $T_A$=25° C | | 1,2<br>6,11 | 6,7<br>8,10<br>11 |
| | | | 0.05 (2.0) | -0.05 (-2.0) | -0.11 (-4.3) | | $T_A$ = 0° to 55° C | | | |
| Tag Scan Velocity | | $v_{scan}$ | 7.6 | | 76 | cm/s | | | 9 | 7 |
| Emitter Peak Wavelength | | λ | | 700 | | nm | $T_A$=25° C | | | |

## TYPICAL WIDTH ERROR PERFORMANCE

($V_S$ = 5V, $T_A$ = 25° C, $R_L$ = 2.2kΩ, unless otherwise noted)

| Parameter | | | Symbol | Typical WE Tilt = 0° Height = 0.25mm | Typical WE Tilt = 30° Height = 0.0mm | Units | Conditions | Fig. | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | From | To | | | | | | | |
| Bar Width Error | Margin | 1st | $\Delta b_1$ | 0.08 (3.2) | 0.11 (4.2) | mm (in.x$10^{-3}$) | Margin ≥ 5mm<br>1b=1s=0.3mm<br>2b=2s=0.6mm<br>$T_A$=25° C<br>$V_S$=5V<br>$v_{scan}$=50cm/s<br>Preferred Orientation<br>Standard Test Tag | 1,2 | 5,7,8 |
| | 1s | 1b | $\Delta b_{1-1}$ | 0.03 (1.2) | 0.04 (1.6) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |
| | 2s | 1b | $\Delta b_{2-1}$ | 0.06 (2.5) | 0.07 (2.9) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |
| | 1s | 2b | $\Delta b_{1-2}$ | 0.02 (0.9) | 0.02 (0.7) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |
| | 2s | 2b | $\Delta b_{2-2}$ | 0.05 (1.9) | 0.05 (2.1) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |
| Space Width Error | 1b | 1s | $\Delta s_{1-1}$ | -0.04 (-1.4) | -0.04 (-1.4) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |
| | 2b | 1s | $\Delta s_{2-1}$ | -0.03 (-1.0) | -0.03 (-1.1) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |
| | 1b | 2s | $\Delta s_{1-2}$ | -0.07 (-2.7) | -0.08 (-3.3) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |
| | 2b | 2s | $\Delta s_{2-2}$ | -0.06 (-2.4) | -0.06 (-2.4) | mm (in.x$10^{-3}$) | | 1,2 | 6,7,8 |

Notes:

1. Storage Temperature is dictated by Wand case.
2. Power supply ripple and noise should be less than 100 mV.
3. Switch bounce causes a series of sub-millisecond pulses to appear at the output, $V_O$. (HEDS-3000 only)
4. Push-to-Read switch is depressed, and the Wand is placed on a non-reflecting (black) surface. (HEDS-3000 only)
5. The margin refers to the reflecting (white) space that preceeds the first bar of the bar code.
6. The interior bars and spaces are those which follow the first bar of bar code tag.
7. The standard test tag consists of black bars, white spaces (0.3 mm, 0.012 in. min.) photographed on Kodagraph Transtar TC5® paper with a print contrast signal greater than 0.9.
8. The print contrast signal (PCS) is defined as: PCS = ($R_w$ - $R_b$) /$R_w$, where $R_w$ is the reflectance at 700 nm from the white spaces, and $R_b$ is the reflectance at 700 nm for the bars.
9. 1.0 in. = 25.4 mm, 1 mm = 0.0394 in.
10. The Wand is in the preferred orientation when the surface of the label is parallel to the height dimension of the bar code.

## OPERATION CONSIDERATIONS

The Wand resolution is specified in terms of a bar and space Width Error, WE. The width error is defined as the difference between the calculated bar (space) width, B, (S), and the optically measured bar (space) widths, b (s). When a constant scan velocity is used, the width error can be calculated from the following.

$B = t_b \cdot v_{scan}$

$S = t_s \cdot v_{scan}$

$\Delta b = B - b$

$\Delta s = S - s$

Where

$\Delta b, \Delta s$ = bar, space Width Error (mm)

b, s = optical bar, space width (mm)

B, S = calculated bar, space width (mm)

$v_{scan}$ = scan velocity (mm/s)

$t_b, t_s$ = wand pulse width output(s)

The magnitude of the width error is dependent upon the width of the bar (space) preceeding the space (bar) being measured. The Guaranteed Width Errors are specified as a maximum for the margin to first bar transition, as well as, maximums and minimums for the bar and space width errors resulting from transitions internal to the body of the bar code character. The Typical Width Error Performance specifies all possible transitions in a two level code (e.g. 2 of 5). For example, the $\Delta b_{2-1}$ Width Error specifies the width error of a single bar module (0.3 mm) when preceeded by a double space module (0.6 mm).

The Bar Width Error $\Delta b$, typically has a positive polarity which causes the calculated bar, B, to appear wider than its printed counterpart. The typical negative polarity of the Space Width Error $\Delta s$, causes the measured spaces to appear narrower. The consistency of the polarity of the bar and space Width Errors suggest decoding schemes which average the measured bars and measured spaces within a character. These techniques will produce a higher percentage of good reads.

The Wand will respond to a bar code with a nominal module width of 0.3 mm when it is scanned at tilt angles between 0° and 30°. The optimum performance will be obtained when the Wand is held in the preferred orientation (Figure 1), tilted at an angle of 10° to 20°, and the Wand tip is in contact with the tag. The Wand height, when held normal to the tag, is measured from the tip's aperture, and when it is tilted it is measured from the tip's surface closest to the tag. The Width Error is specified for the preferred orientation, and using a Standard Test Tag consisting of black bars and white spaces. Figure 2 illustrates the random two level bar code tag. The Standard Test Tag is photographed on Kodagraph Transtar TC5® paper with a nominal module width of 0.3 mm (0.012 in.) and a Print Contrast Signal (PCS) of greater than 90%.

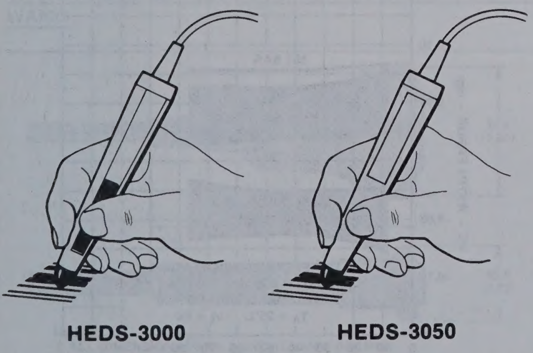
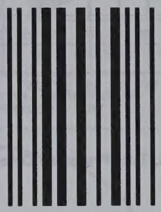

HEDS-3000
HEDS-3050

Figure 1. Preferred Wand Orientation.



BAR WIDTH 0.3 mm (0.012 in.) BLACK & WHITE

$R_{WHITE}$ ≥ 75%, PCS ≥ 0.9 KODAGRAPH TRANSTAR TC5® PAPER

Figure 2. Standard Test Tag Format.

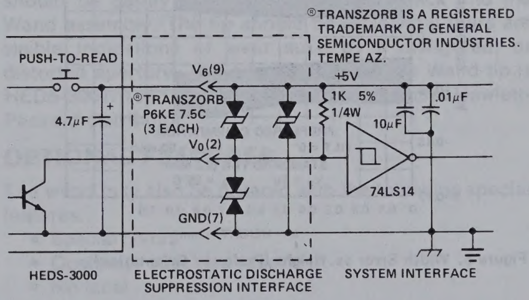

®TRANSZORB IS A REGISTERED TRADEMARK OF GENERAL SEMICONDUCTOR INDUSTRIES. TEMPE AZ.
PUSH-TO-READ
V6(9)
+5V
®TRANSZORB P6KE 7.5C (3 EACH)
4.7μF
1K 5% 1/4W
.01μF
10μF
V0(2)
74LS14
GND(7)
HEDS-3000
ELECTROSTATIC DISCHARGE SUPPRESSION INTERFACE
SYSTEM INTERFACE

Figure 3a. Recommended Logic Interface for HEDS-3000

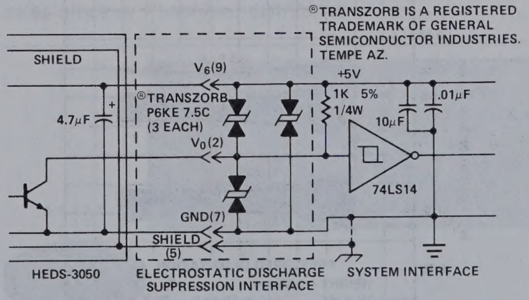

®TRANSZORB IS A REGISTERED TRADEMARK OF GENERAL SEMICONDUCTOR INDUSTRIES. TEMPE AZ.
SHIELD
V6(9)
+5V
®TRANSZORB P6KE 7.5C (3 EACH)
4.7μF
1K 5% 1/4W
.01μF
10μF
V0(2)
74LS14
GND(7)
SHIELD (5)
HEDS-3050
ELECTROSTATIC DISCHARGE SUPPRESSION INTERFACE
SYSTEM INTERFACE

Figure 3b. Recommended Logic Interface for HEDS-3050. (When earth ground is not available, connect shield to logic ground, as shown by dotted line)

# Typical Performance Curves ($R_L = 2.2k\Omega$)

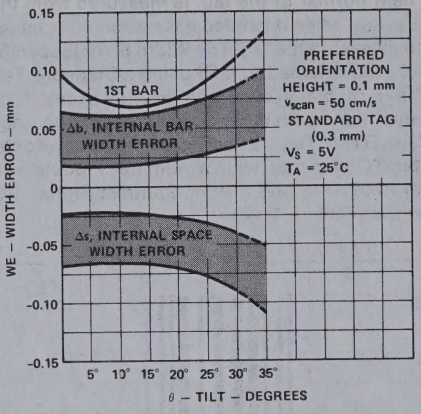


**Figure 4. Width Error vs. Tilt (Preferred Orientation).**

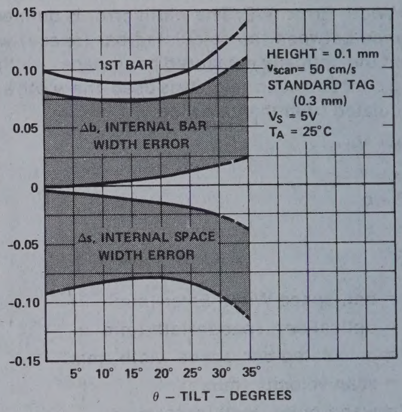


**Figure 5. Width Error vs. Tilt (Any Orientation).**

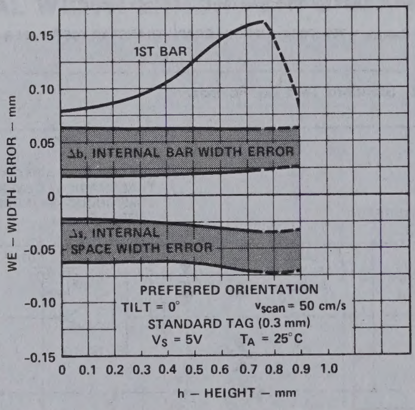


**Figure 6. Width Error vs. Height (Preferred Orientation).**

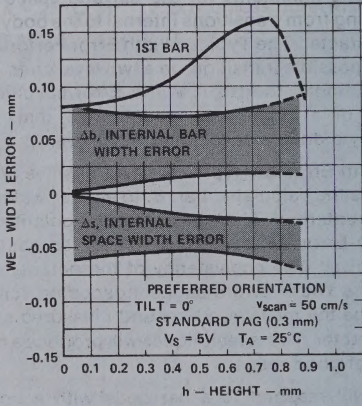


**Figure 7. Width Error vs. Height (Any Orientation).**

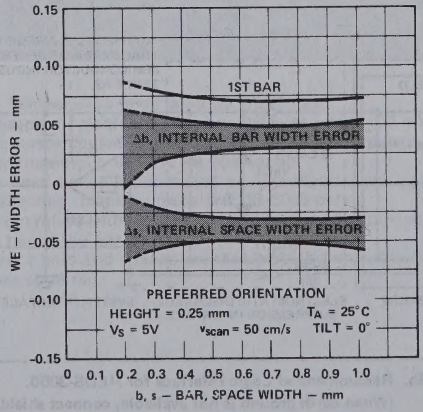


**Figure 8. Width Error vs. Bar Width.**

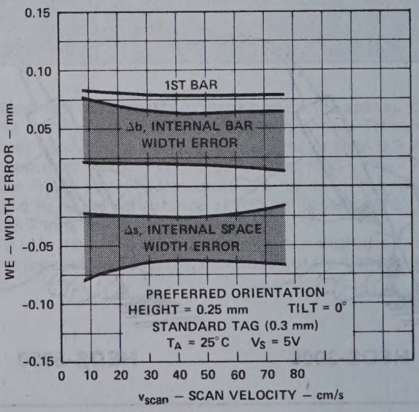


**Figure 9. Width Error vs. Scan Velocity.**

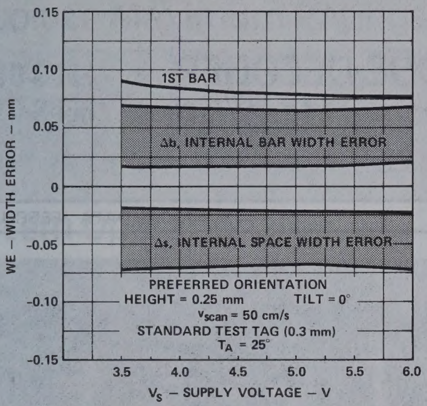


**Figure 10. Width Error vs. Supply Voltage.**

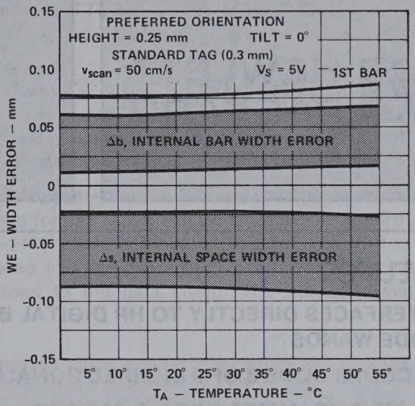


**Figure 11. Width Error vs. Temperature.**

## MECHANICAL CONSIDERATIONS

The HEDS-3000/-3050 include a standard nine pin D-style connector with integral squeeze-to-release retention mechanism. Two types of receptacles with the retention mechanism are available from AMP Corp. (Printed circuit header: 745001-2 Panel mount: 745018, body; 66570-3, pins). Panel mount connectors that are compatible with the Wand connector, but do not include the retention mechanism, are the Molex A7224, and AMP 2074-56-2.

## MAINTENANCE CONSIDERATIONS

While there are no user serviceable parts inside the Wand, the tip should be checked periodically for wear and dirt, or obstructions in the aperture. The tip aperture is designed to reject particles and dirt but a gradual degradation in performance will occur as the tip wears down, or becomes obstructed by foreign materials.

Before unscrewing the tip, disconnect the Wand from the system power source. The aperture can be cleaned with a cotton swab or similar device and a liquid cleaner.

The glass window on the sensor should be inspected and cleaned if dust, dirt, or fingerprints are visible. To clean the sensor window dampen a lint free cloth with a liquid cleaner, then clean the window with the cloth taking care not to disturb the orientation of the sensor. DO NOT SPRAY CLEANER DIRECTLY ON THE SENSOR OR WAND.

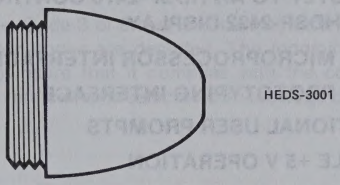


**Figure 12. Wand Tip.**

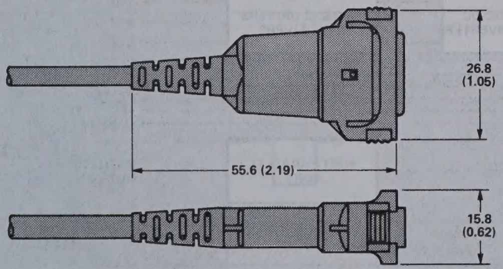
After cleaning the tip aperture and sensor window, the tip should be gently and securely screwed back into the Wand assembly. The tip should be replaced if there are visible indications of wear such as a disfigured, or distorted aperture. The part number for the Wand tip is HEDS-3001. It can be ordered from any franchised Hewlett-Packard distributor.

## OPTIONAL FEATURES

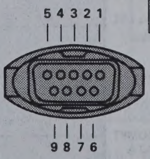
The wand may also be ordered with the following special features:

- Special colors
- Customer specified label
- No label
- Heavy duty retractable coiled cord
- No connector
- With/without switch button

For more information, call your local Hewlett-Packard sales office or franchised distributor.



NOTES:
1. ALL DIMENSIONS IN MILLIMETRES AND (INCHES).



| Pin | Wire Color | HEDS-3000 Function | HEDS-3050 Function |
|---|---|---|---|
| 1 | NC | NC | NC |
| 2 | White | $V_O$ Output | $V_O$ Output |
| 3 | NC | NC | NC |
| 4 | NC | NC | NC |
| 5 | — | NC | Shield |
| 6 | NC | NC | NC |
| 7 | Black | Ground | Ground |
| 8 | NC | NC | NC |
| 9 | Red | $V_S$ Supply Voltage | $V_S$ Supply Voltage |

**Figure 13. Connector Specifications.**

**HEWLETT PACKARD**

# BAR CODE DECODER MODULE

## HEDS-0100
## HEDS-0150

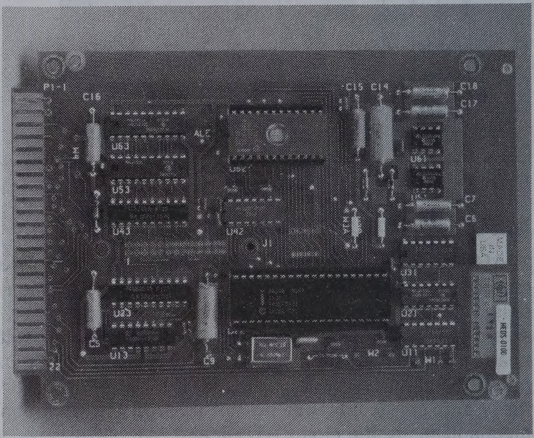
TECHNICAL DATA FEBRUARY 1982

## Features

- **INTERFACES DIRECTLY TO HP DIGITAL BAR CODE WANDS**
- **DECODES CODE 3 OF 9 BI-DIRECTIONALLY**
- **RS-232-C TRANSMIT PORT, 2400 BAUD**
- **8-BIT PARALLEL ASCII PORT, INTERFACES DIRECTLY TO AN HDSP-2470 CONTROLLER AND HDSP-2432 DISPLAY**
- **EASY MICROPROCESSOR INTERFACE**
- **EASY PROTOTYPING INTERFACE**
- **7 OPTIONAL USER PROMPTS**
- **SINGLE +5 V OPERATION**
- **TTL COMPATIBLE**
- **STANDARD 44 PIN EDGE CONNECTOR .156" CENTERS (HEDS-0100)**
- **DIN 41612B MALE 64 PIN CONNECTOR (HEDS-0150)**

## Description

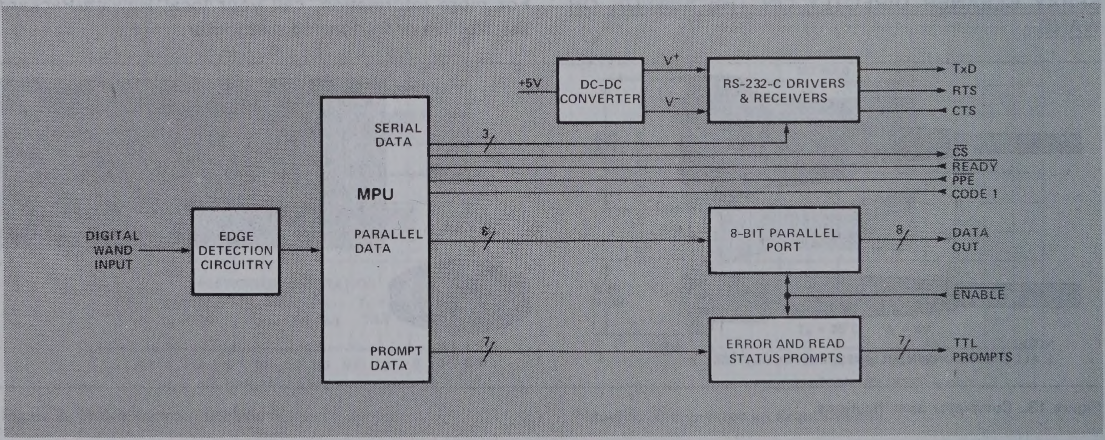
The HEDS-01XX is a fully integrated bar code decoder board which decodes code 3 of 9. The data from HP Digital Bar Code Wands, such as the HEDS-3050, is decoded and output over a parallel ASCII port or a serial ASCII RS-232-C port. Optional user prompts showing both wanding errors and read status are available to help increase the user read rate. The bipolar voltages required for the RS-232-C port are generated on-board by a DC-DC converter.



## Applications

The HEDS-01XX has been designed as an integral bar code decoding printed circuit board for installation within most data entry terminals. The board can function either as a dedicated data collection terminal or as a slave MPU board within the user's terminal. In a dedicated function, the HEDS-01XX serves as the heart of a stand-alone terminal where communication to the host processor is through a transmit only RS-232-C port with a handshake. As a slave MPU board, the HEDS-01XX operates in tandem with the user's terminal where communication to the host processor is provided by the terminal. The compact size and choice of output configurations make the HEDS-01XX compatible with most terminals.

## Block Diagram


+5V
DC-DC CONVERTER
V+
V-
RS-232-C DRIVERS & RECEIVERS
TxD
RTS
CTS
SERIAL DATA
3
$\overline{CS}$
$\overline{READY}$
$\overline{PPE}$
CODE 1
MPU
DIGITAL WAND INPUT
EDGE DETECTION CIRCUITRY
PARALLEL DATA
8
8-BIT PARALLEL PORT
8
DATA OUT
$\overline{ENABLE}$
PROMPT DATA
7
ERROR AND READ STATUS PROMPTS
7
TTL PROMPTS

# Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Storage Temperature | $T_S$ | -40 | 70 | °C |
| Operating Temperature | $T_A$ | 0 | 55 | °C |
| Supply Voltage | $V_S$ | -0.5 | 6.0 | V |

# System Operational Characteristics (over operating temperature range)

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Supply Current | $I_S$ | | 350 | 600 | mA | 0.3 mm nominal bar width<br>2.2:1 ratio wide to narrow |
| Scan Velocity | $V_{SCAN}$ | 7.6 | | 76 | cm/s | |

# Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Supply Voltage | $V_S$ | 4.75 | 5.25 | V[1] |
| Temperature | $T_A$ | 0 | 55 | °C |
| Relative Humidity (non-condensing) | RH | 5 | 95 | % |
| Power Supply Rise Time | $T_{PS}$ | 100 | | V/s |

**Note:**

1. Power supply noise and ripple should be less than 100 mV p-p.

**Data Input** — TTL pulse train from HP Digital Wands. The required pull-up resistor is located on the printed circuit board.

**Serial Output** — ASCII RS-232-C at 2400 Baud with one start bit, seven data bits, parity bit set to zero, and one stop bit. A "mark" is represented by $V^-$ and a "space" by $V^+$. The serial port is driven by an MC1488 line driver.

**Parallel Output** — 8-bit ASCII with bit 7 set to zero. This is designed for use with an HDSP-2432 display board and an HDSP-2470 controller board. This tri-state port is easily interfaced to microprocessors. Start and stop characters are added to the data string. The output format is as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| 0A$_{16}$ (LF) | 00$_{16}$ (NULL) | DATA WORD | DATA WORD | | DATA WORD | 7F$_{16}$ (DEL) |

The driver for the parallel port is a 74LS244.

**Bar Code** — Code 3 of 9 may be scanned bidirectionally. No other bar codes are decoded. The incoming data is checked to insure that it complies with the code rules. Checksum verification is selectable on the edge connector.

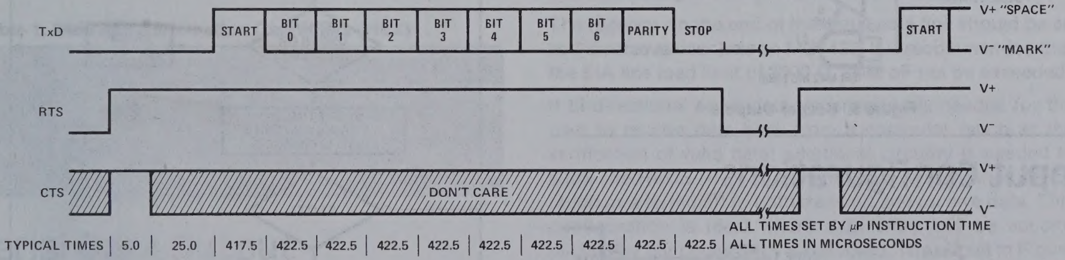

TxD
START
BIT 0
BIT 1
BIT 2
BIT 3
BIT 4
BIT 5
BIT 6
PARITY
STOP
START
V+ "SPACE"
V⁻ "MARK"
RTS
V+
V⁻
CTS
DON'T CARE
V+
V⁻
ALL TIMES SET BY μP INSTRUCTION TIME
TYPICAL TIMES | 5.0 | 25.0 | 417.5 | 422.5 | 422.5 | 422.5 | 422.5 | 422.5 | 422.5 | 422.5 | 422.5 | 422.5 |
ALL TIMES IN MICROSECONDS

Figure 1. RS-232-C Character Transfer

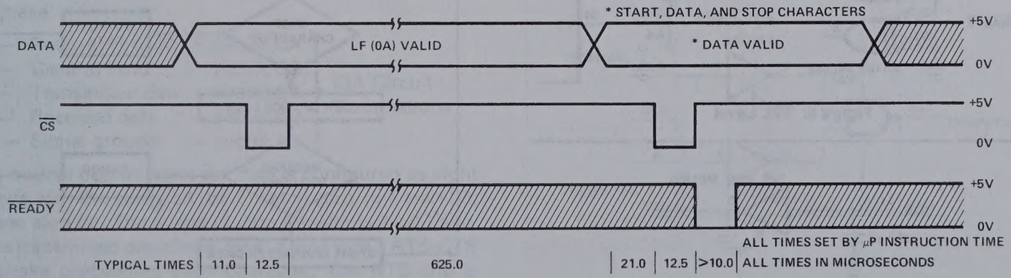

* START, DATA, AND STOP CHARACTERS
DATA
LF (0A) VALID
* DATA VALID
+5V
0V
CS
+5V
0V
READY
+5V
0V
ALL TIMES SET BY μP INSTRUCTION TIME
TYPICAL TIMES | 11.0 | 12.5 | 625.0
| 21.0 | 12.5 | >10.0 |
ALL TIMES IN MICROSECONDS

Figure 2. Parallel Character Transfer

# Output Configurations

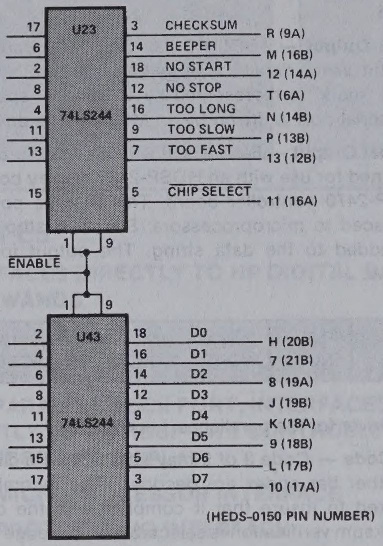

U23
74LS244
17
6
2
8
4
11
13
15
3 CHECKSUM R (9A)
14 BEEPER M (16B)
18 NO START 12 (14A)
12 NO STOP T (6A)
16 TOO LONG N (14B)
9 TOO SLOW P (13B)
7 TOO FAST 13 (12B)
5 CHIP SELECT 11 (16A)
1
9
ENABLE
1
9
U43
74LS244
2
4
6
8
11
13
15
17
18 D0 H (20B)
16 D1 7 (21B)
14 D2 8 (19A)
12 D3 J (19B)
9 D4 K (18A)
7 D5 9 (18B)
5 D6 L (17B)
3 D7 10 (17A)
(HEDS-0150 PIN NUMBER)

**Figure 3. Parallel Prompts and Data**

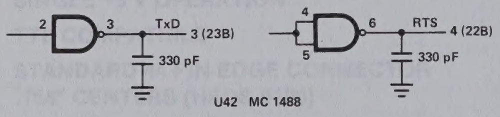

2
3
TxD
3 (23B)
330 pF
4
5
6
RTS
4 (22B)
330 pF
U42 MC 1488

**Figure 4. Serial Data**

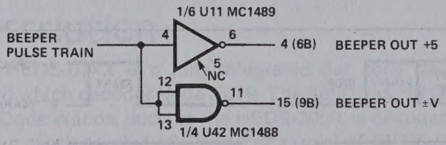

1/6 U11 MC1489
BEEPER PULSE TRAIN
4
6
5
NC
4 (6B)
BEEPER OUT +5
12
11
13
15 (9B)
BEEPER OUT ±V
1/4 U42 MC1488

**Figure 5. Beeper Outputs**

# Input Configurations

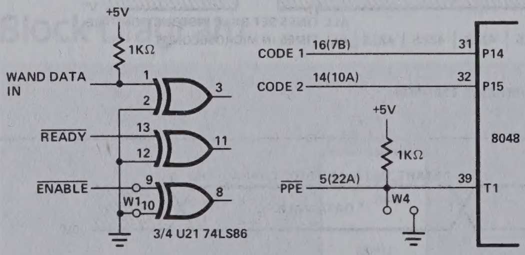

+5V
1KΩ
WAND DATA IN
1
2
3
READY
13
12
11
ENABLE
9
10
8
W1
3/4 U21 74LS86
CODE 1
16(7B)
31
P14
CODE 2
14(10A)
32
P15
+5V
1KΩ
8048
PPE
5(22A)
39
T1
W4

**Figure 6. TTL Level**

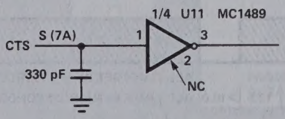

1/4 U11 MC1489
CTS
S (7A)
330 pF
1
3
2
NC

**Figure 7. RS-232-C Level**

# System Overview

The HEDS-0100/-0150 accepts serial TTL data from Hewlett-Packard Digital Wands and converts this data into the ASCII characters represented. These characters are then output through the serial and parallel data ports.

An internal timer measures the input TTL data pulse widths and compares their value to a reference to determine a logic value. After a start character has been recognized, the decoded data bits are shifted into a 9-bit data word. When a complete word has been collected, the corresponding ASCII character is determined through the use of a look-up table. The decoded characters are stored in a message buffer until a stop character is seen. At this point the message is output to the selected data ports.

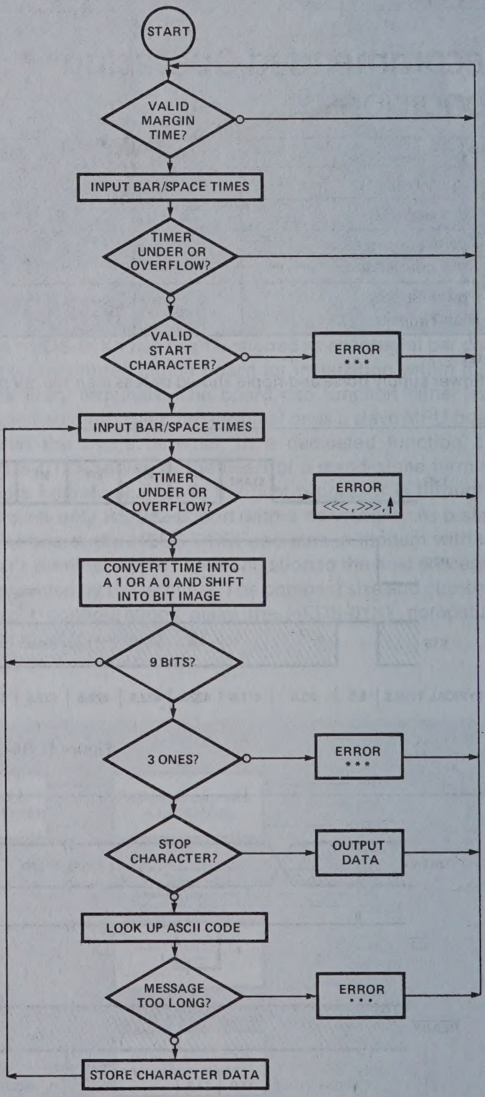

START
VALID MARGIN TIME?
INPUT BAR/SPACE TIMES
TIMER UNDER OR OVERFLOW?
VALID START CHARACTER?
ERROR ***
INPUT BAR/SPACE TIMES
TIMER UNDER OR OVERFLOW?
ERROR <<<,>>>,↑
CONVERT TIME INTO A 1 OR A 0 AND SHIFT INTO BIT IMAGE
9 BITS?
3 ONES?
ERROR ***
STOP CHARACTER?
OUTPUT DATA
LOOK UP ASCII CODE
MESSAGE TOO LONG?
ERROR ···
STORE CHARACTER DATA

**Figure 8. System Software Flow Chart**

The user interfaces to the system through a WAND DATA input line, a transmit-only RS-232-C port, an 8-bit parallel port, five error and two read status prompts, and an $\overline{\text{ENABLE}}$ line that controls the tri-state capability of the parallel port and the prompt lines. Except for the RS-232-C port, all inputs and outputs are TTL compatible. The serial and parallel ports can be selected separately or simultaneously. The block diagram of the system is on the bottom of page 1, and the flowchart of the basic system software is in Figure 8.

# Parallel Data Output

Data can be output through the parallel port in two modes, normal or polled. With the HEDS-01XX operating in the normal mode, the first start character (Table 1) is output without a handshake. This can be used to clear a display. To accomplish this, the $\overline{\text{CS}}$ line is lowered for 12 μs followed by a pause of 625 μs for the parallel device to accept the data (Figure 2). The second start character is then output with the $\overline{\text{READY}}$ line handshake (Figure 2). When the handshake is complete, the first character of data is output. After the complete message has been sent, the termination character is output.

Operation of the polled mode would be as follows. When the host processor requests information, it enables the parallel bus by lowering the $\overline{\text{ENABLE}}$ line. If a NULL is present on the bus, it means character data is ready for transfer. The $\overline{\text{READY}}$ line is toggled low to signal the decoder that the host is ready for the next character. When the character data is valid, the decoder will lower the $\overline{\text{CS}}$ line for 12 μs. After the host has accepted a character, the $\overline{\text{READY}}$ line should be toggled low. The $\overline{\text{READY}}$ line should be toggled when a DEL is received to signal the decoder that the host has received all of the data.

**Table 1. Start and Termination Characters (HEX)**

| Port | Start | Termination |
|---|---|---|
| Parallel | LF, Null<br>(0A) (00) | Del<br>(7F) |
| Serial | — | CR, LF<br>(20) (0A) |

# Serial Data Output Transmit Only RS-232-C

The serial port is a transmit only RS-232-C port. The five lines listed below are used for serial communication with a handshake.

RTS — Request to send — circuit CA
CTS — Clear to send — circuit CB
TxD — Transmitted data — circuit BA
RxD — Received data — circuit BB
GND — Signal ground — circuit AB

EIA Circuit Designations

In the normal output mode the data is configured as eight data bits with the parity bit (bit 7) set to zero, one start bit, and one stop bit. The speed of data transfer is 2400 baud. Data is transmitted one character at a time with a RTS-CTS handshake preceeding each character. The RTS line is raised and the HEDS-01XX waits for the CTS line to go high (Figure 1). After this occurs a character is transmitted.

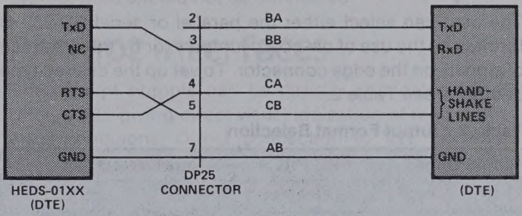


**Figure 9. RS-232-C Connection for Communication to a DTE.**

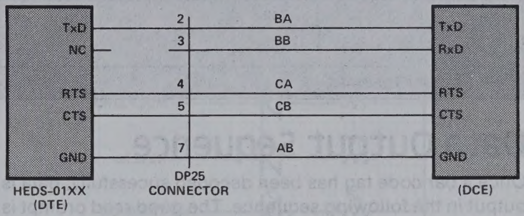


**Figure 10. RS-232-C Connection for Communication to a DCE.**

When the RS-232-C port is disabled by inserting jumper W2 or by inputting $V^+$ to the CTS line, data is still transmitted, but no handshake is required.

For the HEDS-01XX to communicate to a piece of Data Terminal Equipment (DTE), the DP25 connector should be wired as shown in Figure 9. When communications to a piece of Data Communications Equipment (DCE) is necessary, the wiring shown in Figure 10 should be used.

The receiver on the end of the serial data line should be an active receiver, such as an MC1489. It is recommended that the EIA line load limit of 3000 Ω, 2500 pF not be exceeded.

If bi-directional serial data transmission is needed for the user to receive data back from a computer (such as the verification of valid data) additional circuitry is needed to allow the HEDS-01XX to transmit data and another device (such as a terminal) to both transmit and receive data. This configuration is ideal where data entry can be accomplished by bar codes or by a keyboard. The circuit in Figure 11 will accomplish this function. It assumes that jumper W2 has been inserted.

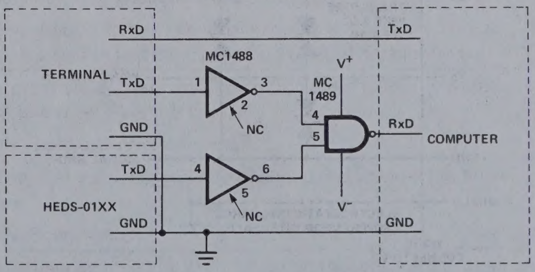


**Figure 11. RS-232-C Parallel Connection HEDS-01XX and Terminal to Computer**

# Output Format Selection

The user can select either the parallel or serial RS-232-C formats by the use of on-board jumpers, or by the presence of signals on the edge connector. To set up the desired type of output, see Table 2.

**Table 2. Output Format Selection**

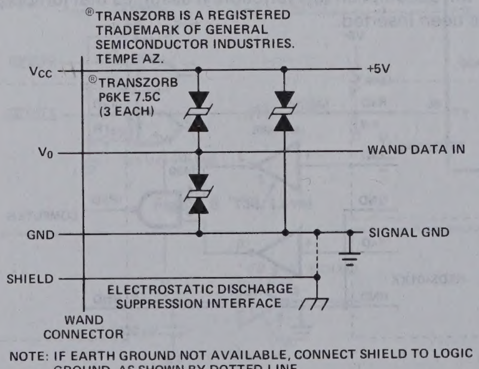
| Jumper | | PC PIN | | Modes Selected |
|---|---|---|---|---|
| W1 | W2 | CTS | READY | |
| — | — | — | — | Serial and Parallel |
| X | — | — | — | Serial |
| — | — | — | GND | |
| — | X | — | — | Parallel |
| — | — | V+ | — | |
| X = Jumper Inserted. | | | | |

# Data Output Sequence

Once a bar code tag has been decoded sucessfully, data is output in the following sequence. The good read prompt is lowered for the duration of the good read beep. If checksum verification has been selected, and the last character of the message is the correct checksum for the message, the checksum prompt line is lowered and the checksum character is suppressed. The parallel port start characters are sent (Table 1), followed by the first message character. After the parallel handshake, the first character is output on the serial port. The process of transmitting one character over the parallel port and then over the serial port is repeated until all characters have been sent. When the data transfer is complete, the serial port terminators are sent, followed by the parallel port termination character. The parallel port termination character is the last character transmitted. If one of the output ports has been disabled, all output to that port is skipped.

# Wand Input

To minimize the possibility of coupling noise onto the wand data line, it is recommended that the lead length from the wand connector to the PC connector be kept as short as possible. To prevent electrostatic discharge from harming the decoder board or the wand, Transzorbs® should be placed physically and electrically as close as possible to the wand connector. (Figure 12) The shield pin of the HEDS-3050 wand should be connected to earth ground to prevent the coupling of line frequency noise onto the wand data line. If earth ground is not available, the shield should be connected to signal ground.


®TRANSZORB IS A REGISTERED TRADEMARK OF GENERAL SEMICONDUCTOR INDUSTRIES. TEMPE AZ.
VCC
+5V
®TRANSZORB P6KE 7.5C (3 EACH)
V0
WAND DATA IN
GND
SIGNAL GND
SHIELD
ELECTROSTATIC DISCHARGE SUPPRESSION INTERFACE
WAND CONNECTOR

NOTE: IF EARTH GROUND NOT AVAILABLE, CONNECT SHIELD TO LOGIC GROUND, AS SHOWN BY DOTTED LINE.

**Figure 12. Logic Interface for HEDS-3050**

# Checksum Calculation Code 3 of 9

**Selection of Checksum Verification**

| PC Board Lines | | |
|---|---|---|
| **Code 1** | **Code 2** | **Result** |
| 1 | X | Checksum verification |
| 0 | X | No checksum verification |

Checksums are used to reduce substitution errors in the system. When such an error happens, the calculated checksum will not match the printed checksum, and checksum verification will not occur.

If checksum verification is selected, the checksum of a code 3 of 9 data string is calculated as follows. Each character in the message string has an assigned numeric value as shown in Table 3. These checksum values are modulus 43 summed over the entire message. From this total a message checksum character is generated. The last character of the string is compared to the checksum character and if a match exists, the checksum prompt is lowered and the last character is not transmitted over either port.

**Table 3. Code 3 of 9 ASCII Conversion Table**

| ASCII Character | Binary Word | Bars | Spaces | Checksum Value |
|---|---|---|---|---|
| 0 | 000110100 | 00110 | 0100 | 0 |
| 1 | 100100001 | 10001 | 0100 | 1 |
| 2 | 001100001 | 01001 | 0100 | 2 |
| 3 | 101100000 | 11000 | 0100 | 3 |
| 4 | 000110001 | 00101 | 0100 | 4 |
| 5 | 100110000 | 10100 | 0100 | 5 |
| 6 | 001110000 | 01100 | 0100 | 6 |
| 7 | 000100101 | 00011 | 0100 | 7 |
| 8 | 100100100 | 10010 | 0100 | 8 |
| 9 | 001100100 | 01010 | 0100 | 9 |
| A | 100001001 | 10001 | 0010 | 10 |
| B | 001001001 | 01001 | 0010 | 11 |
| C | 101001000 | 11000 | 0010 | 12 |
| D | 000011001 | 00101 | 0010 | 13 |
| E | 100011000 | 10100 | 0010 | 14 |
| F | 001011000 | 01100 | 0010 | 15 |
| G | 000001101 | 00011 | 0010 | 16 |
| H | 100001100 | 10010 | 0010 | 17 |
| I | 001001100 | 01010 | 0010 | 18 |
| J | 000011100 | 00110 | 0010 | 19 |
| K | 100000011 | 10001 | 0001 | 20 |
| L | 001000011 | 01001 | 0001 | 21 |
| M | 101000010 | 11000 | 0001 | 22 |
| N | 000010011 | 00101 | 0001 | 23 |
| O | 100010010 | 10100 | 0001 | 24 |
| P | 001010010 | 01100 | 0001 | 25 |
| Q | 000000111 | 00011 | 0001 | 26 |
| R | 100000110 | 10010 | 0001 | 27 |
| S | 001000110 | 01010 | 0001 | 28 |
| T | 000010110 | 00110 | 0001 | 29 |
| U | 110000001 | 10001 | 1000 | 30 |
| V | 011000001 | 01001 | 1000 | 31 |
| W | 111000000 | 11000 | 1000 | 32 |
| X | 010010001 | 00101 | 1000 | 33 |
| Y | 110010000 | 10100 | 1000 | 34 |
| Z | 011010000 | 01100 | 1000 | 35 |
| — | 010000101 | 00011 | 1000 | 36 |
| | 110000100 | 10010 | 1000 | 37 |
| SPACE | 011000100 | 01010 | 1000 | 38 |
| • | 010010100 | 00110 | 1000 | 39 |
| $ | 010101000 | 00000 | 1110 | 40 |
| / | 010100010 | 00000 | 1101 | 41 |
| + | 010001010 | 00000 | 1011 | 42 |
| % | 000101010 | 00000 | 0111 | 43 |

For example if a checksum is to be generated for the message HEWLETT PACKARD, the sum of the characters would be as follows:

17 + 14 + 32 + 21 + 14 + 29 + 29 + 38 + 25 + 10 + 12 + 20 + 10 + 27 + 13 = 311
H E W L E T T P A C K A R D

The modulus 43 sum is determined by dividing the total by 43 and keeping the remainder.

311/43 = 7 Remainder 10

The numeric value 10 corresponds to the letter A. The complete message with the checksum added becomes HEWLETT PACKARDA.

## Decoding Prompts

To help the user achieve the highest possible read rate, seven operator prompts are available to aid in learning proper scanning techniques. Of the seven prompts, five signal errors and two signal read status. The five error prompts are available as ASCII prompts over the parallel port, and as TTL levels that go through 74LS244 drivers. The five error prompts, their ASCII symbols, causes and suggested solutions are listed in Table 4.

The two read status prompts signify whether or not a checksum character was present at the end of the message, and if a good read occurred. These prompts are available only as TTL levels. If the last character in the data string is the valid checksum, and if checksum verification has been selected, the checksum prompt is lowered and the checksum character is not transmitted. When the good read prompt is activated, it goes low for the duration of the beeper signal (16 ms). These prompts can be used to verify that data entered into the system is good.

If the ASCII prompts are desired on the parallel port, they may be enabled by either inserting jumper W4 or by driving line $\overline{PPE}$ low. If they are not desired, remove jumper W4 and let line $\overline{PPE}$ float. If the TTL prompts are not needed, the prompt lines should not be connected.

## Prompt Interfaces

The prompt outputs can be directly connected to LEDs (Figure 13), giving direct visual indication of read status or error conditions. Direct connection to TTL circuitry to verify good data is also possible (Figure 14). Since the good read beeper signal is quite short (16 ms), a longer signal may be needed. The pulse stretcher in the left half of Figure 15 can lengthen the pulse to any desired value. If an external oscillator is needed in conjunction with the pulse stretcher, the circuit in Figure 15 will give an audible signal of almost any duration and frequency without affecting the decoding cycle time of the processor.

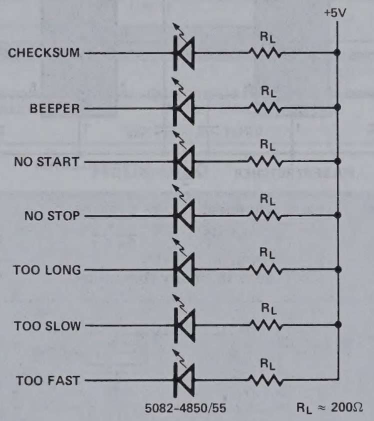
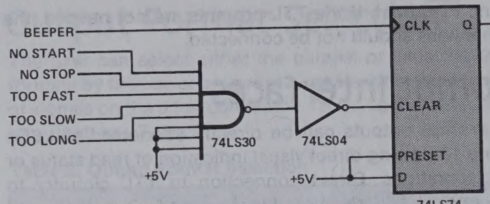


Figure 13. TTL Prompt Connection to LEDs

Table 4. ASCII Error Prompts

| Prompt Symbol | Prompt Definition | Cause and Solution |
|---|---|---|
| *** | No Start Character/ Invalid Character | CAUSE: Either a valid start character pattern was not recognized at the beginning of a bar code message, or a message character did not have three wide elements. This is caused by the user missing part of the first character, or by scanning a defective bar code label.<br>SOLUTION: Make sure that the label is good. If it is, start the scan before the first bar and complete it after the last bar. |
| ↑ | No Stop Character | CAUSE: A valid stop character pattern was not seen at the end of a bar code label. The user either has a bad label or has exited the bar code symbol before the end of the label.<br>SOLUTION: Make sure that the label is good. If it is, make sure to end the scan after the last bars, scanning over all bars in the tag. |
| ... | Bar Code Message too Long | CAUSE: More than 29 characters, including the checksum, were scanned in one label.<br>SOLUTION: Scan a shorter bar code. |
| <<< | Bar Code Scanned too Fast | CAUSE: The user scanned at a rate of speed that caused the timer to underflow.<br>SOLUTION: Scan slower. |
| >>> | Bar Code Scanned too Slow | CAUSE: The user scanned at a rate of speed that caused the timer to overflow.<br>SOLUTION: Scan faster. |


BEEPER
NO START
NO STOP
TOO FAST
TOO SLOW
TOO LONG
+5V
74LS30
74LS04
+5V
CLK
Q
CLEAR
PRESET
D
74LS74

Q HIGH FOR GOOD READ

Figure 14. Good Read Verification

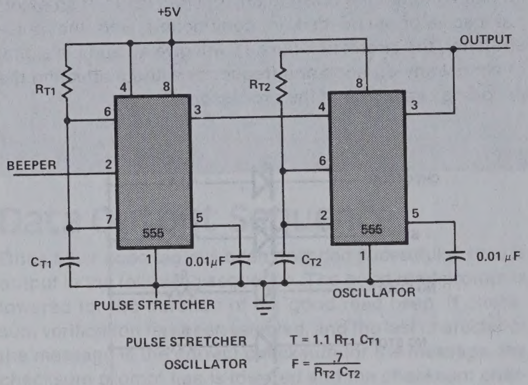

+5V
OUTPUT
$R_{T1}$
4
8
6
3
BEEPER
2
7
5
555
1
$C_{T1}$
0.01μF
PULSE STRETCHER
$R_{T2}$
8
4
3
6
2
5
555
1
$C_{T2}$
0.01 μF
OSCILLATOR
PULSE STRETCHER
OSCILLATOR
$T = 1.1\,R_{T1}\,C_{T1}$
$F = \frac{.7}{R_{T2}\,C_{T2}}$

Figure 15. Tone Generator

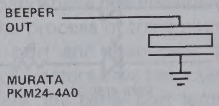

BEEPER
OUT
MURATA
PKM24-4A0

Figure 16. Direct Beeper Connection

In addition to the LED prompt, the good read signal is also generated as a pulse train. Two separate voltage levels, a TTL level, and an RS-232-C level, are available. The TTL level is driven by an MC1489 and is available on pin U (6B). The RS-232-C level is driven by an MC1488 and is present in pin 15 (9B). These outputs can be directly connected to a piezioelectric crystal to generate the good read beep, (Figure 16), or they can be sent to an amplifier to power any kind of annunciator desired.

## Prototyping Interface

A prototype bar code data entry system is often required to demonstrate the concept of bar codes as an alternative to other forms of data entry. To assist a system designer, space for a connector (J1) that directly connects to an HDSP-2470 controller board has been provided. An HDSP-2432 display board is recommended. 3M connector No. 3429-2002 is recommended to solder directly onto the decoder board. Since this interface is the same as the parallel interface, both cannot be used at the same time. A 1.0 μF capacitor is needed to properly power up the display system, and space is provided ( C22, HEDS-01XX drawings, page 8). The display system can be powered from a separate power supply as long as there is a common ground. The power supply requirements of the display system are 5V @ 2A and a voltage rise time of 100 V/s.

## Read Rate Considerations

To achieve a high read rate, several factors need to be considered. The decoder needs a proper margin or "quiet zone" before a first bar of a bar code to recognize that the wand transitions being generated come from valid bar code. The margin should be at least 1 cm. Cycle time (the time required between scans) has a large effect on repetitive read rate. The main contribution to the length of the cycle time is the length of the message. As message length increases, more time is spent in the output routines. The speed which the handshakes are answered will affect the time spent in the output routines. If several codes are to be scanned in rapid succession, proper margins should be used. (Figure 18).

To properly scan a bar code, place the wand in the preferred orientation with the tip approximately 1 cm from the first bar of the code. Use the wand to draw an imaginary line through the center of the bar code, finishing the scan after all bars and spaces have been passed over. To prolong wand tip and bar code tag life, the wand tip needs only to be in light contact with the bar code tag surface.

## Self-Test Character

The self-test character (Figure 19) can be used to verify that the HEDS-01XX is operating properly. When the character is scanned a good read beep is sounded. The program then checks all of the RAM that is used for decoding and outputs the result of the test, either RAM GOOD or RAM BAD, over the selected output ports. After a .5 second delay, the program generates a 8-bit checksum of all bytes of program memory and compares this to the proper value. The result ROM GOOD or ROM BAD is output as before. The revision number message HEDS-0100/0150 REV X.XX is output followed by a beeper test. The LED prompts are then lowered for .5 seconds each in the order shown in Figure 13.

The minimum system required for the self-test is a HEDS-01XX, a wand, and one of the output ports connected (Figure 17). The self-test routine will output to the prompt LEDs and to the BEEPER regardless of whether or not they are present. The self-test function is ideal for an incoming QA test to verify proper operation of the HEDS-01XX.

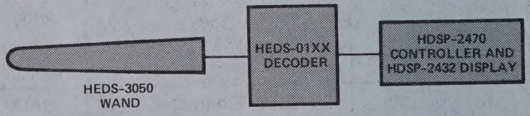

HEDS-3050
WAND
HEDS-01XX
DECODER
HDSP-2470
CONTROLLER AND
HDSP-2432 DISPLAY

Figure 17. Minimum System Required

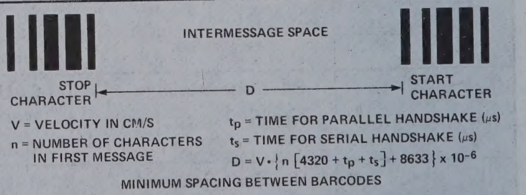

INTERMESSAGE SPACE
STOP
CHARACTER
D
START
CHARACTER
V = VELOCITY IN CM/S
n = NUMBER OF CHARACTERS IN FIRST MESSAGE
$t_p$ = TIME FOR PARALLEL HANDSHAKE (μs)
$t_s$ = TIME FOR SERIAL HANDSHAKE (μs)
$D = V \cdot \{ n \, [4320 + t_p + t_s] + 8633 \} \times 10^{-6}$
MINIMUM SPACING BETWEEN BARCODES

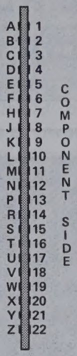
Figure 18. Minimum Intermessage Space

Figure 19. Self-Test Character

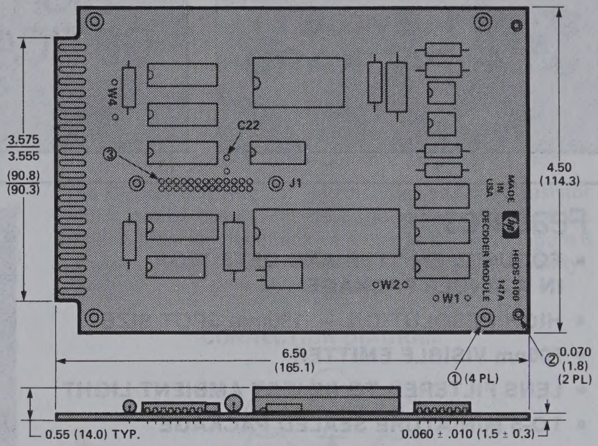
# Board Dimensions

## HEDS-0100 PINOUT

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | GND | A | GND |
| 2 | $V_{CC}$ | B | $V_{CC}$ |
| 3 | TxD | C | NC |
| 4 | RTS | D | NC |
| 5 | $\overline{\text{PPE}}$ | E | NC |
| 6 | NC | F | NC |
| 7 | DATA 1 | H | DATA 0 |
| 8 | DATA 2 | J | DATA 3 |
| 9 | DATA 5 | K | DATA 4 |
| 10 | DATA 7 | L | DATA 6 |
| 11 | $\overline{\text{CHIP SELECT}}$ | M | BEEPER |
| 12 | NO START CHAR | N | TOO LONG |
| 13 | TOO FAST | P | TOO SLOW |
| 14 | CODE 2 | R | CHECKSUM |
| 15 | BEEPER OUT (± V) | S | CTS |
| 16 | CODE 1 | T | NO STOP CHAR |
| 17 | NC | U | BEEPER OUT (+5 V) |
| 18 | $\overline{\text{READY}}$ | V | NC |
| 19 | V+ | W | V– |
| 20 | $\overline{\text{ENABLE}}$ | X | WAND DATA IN |
| 21 | NC | Y | NC |
| 22 | GND | Z | GND |


A
B
C
D
E
F
H
J
K
L
M
N
P
R
S
T
U
V
W
X
Y
Z
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
COMPONENT SIDE

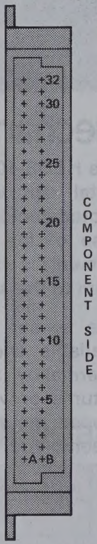
### HEDS-0100


W4
C22
③
J1
W2
W1
MADE IN USA
DECODER MODULE
HEDS-0100
147A
3.575
3.555
(90.8)
(90.3)
4.50
(114.3)
6.50
(165.1)
① (4 PL)
② 0.070
(1.8)
(2 PL)
0.55 (14.0) TYP.
0.060 ± .010 (1.5 ± 0.3)

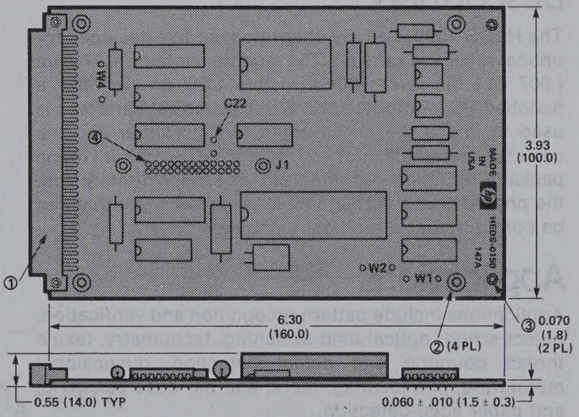
NOTES: ① MTG HOLES FOR #6 SCREW
② CARD EXTRACTOR HOLE
③ MTG HOLES PROVIDED FOR CONNECTOR J1
3M SCOTCHFLEX 3429-2002

## HEDS-0150 PINOUT

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1A | GND | 1B | GND |
| 2A | NC | 2B | NC |
| 3A | $\overline{\text{ENABLE}}$ | 3B | WAND DATA IN |
| 4A | GND | 4B | GND |
| 5A | V+ | 5B | V– |
| 6A | NO STOP CHAR | 6B | BEEPER OUT (+5 V) |
| 7A | CTS | 7B | CODE 1 |
| 8A | NC | 8B | NC |
| 9A | CHECKSUM | 9B | BEEPER OUT (± V) |
| 10A | CODE 2 | 10B | NC |
| 11A | NC | 11B | NC |
| 12A | NC | 12B | TOO FAST |
| 13A | NC | 13B | TOO SLOW |
| 14A | NO START CHAR | 14B | TOO LONG |
| 15A | NC | 15B | NC |
| 16A | $\overline{\text{CHIP SELECT}}$ | 16B | BEEPER |
| 17A | DATA 7 | 17B | DATA 6 |
| 18A | DATA 4 | 18B | DATA 5 |
| 19A | DATA 2 | 19B | DATA 3 |
| 20A | $\overline{\text{READY}}$ | 20B | DATA 0 |
| 21A | NC | 21B | DATA 1 |
| 22A | $\overline{\text{PPE}}$ | 22B | RTS |
| 23A | NC | 23B | TxD |
| 24A | NC | 24B | NC |
| 25A | NC | 25B | NC |
| 26A | NC | 26B | NC |
| 27A | NC | 27B | NC |
| 28A | NC | 28B | NC |
| 29A | NC | 29B | NC |
| 30A | NC | 30B | NC |
| 31A | $V_{CC}$ | 31B | $V_{CC}$ |
| 32A | GND | 32B | GND |


32
30
25
20
15
10
5
A
B
COMPONENT SIDE

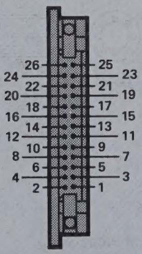
### HEDS-0150


W4
C22
④
J1
W2
W1
MADE IN USA
HEDS-0150
147A
①
3.93
(100.0)
6.30
(160.0)
② (4 PL)
③ 0.070
(1.8)
(2 PL)
0.55 (14.0) TYP
0.060 ± .010 (1.5 ± 0.3)

NOTES: ① DIN41612 B 64 PIN MALE CONNECTOR
② FOR NO. 6 SCREW
③ CARD EXTRACTOR HOLE
④ MTG HOLES PROVIDED FOR CONNECTOR J1
3M SCOTCH FLEX 3429-2002

## PINOUT OF CONNECTOR J1

| | |
|---|---|
| 1 | $\overline{\text{CHIP SELECT}}$ |
| 2 | NC |
| 3 | NC |
| 4 | DATA 7 |
| 5 | NC |
| 6 | C22 |
| 7 | NC |
| 8 | NC |
| 9 | NC |
| 10 | NC |
| 11 | DATA 0 |
| 12 | NC |
| 13 | DATA 1 |
| 14 | NC |
| 15 | DATA 2 |
| 16 | NC |
| 17 | DATA 3 |
| 18 | NC |
| 19 | DATA 4 |
| 20 | NC |
| 21 | DATA 5 |
| 22 | $\overline{\text{READY}}$ |
| 23 | DATA 6 |
| 24 | NC |
| 25 | NC |
| 26 | NC |


26
24
22
20
18
16
14
12
10
8
6
4
2
25
23
21
19
17
15
13
11
9
7
5
3
1

## RECOMMENDED WAND CONNECTORS

| | |
|---|---|
| AMP 745001-2 | PC Header |
| AMP 745018 body; 66570-3 pins | Panel Mount |
| AMP 2074-56-2 | |
| MOLEX A7224 | |

## RECOMMENDED PC BOARD CONNECTORS

| | |
|---|---|
| TRW CINCH 251 22 30 261 | |
| TRW CINCH 251 22 30 260 | |
| TRW CINCH 251 22 30 161 | |
| TRW CINCH 251 22 30 160 | |
| ITT CANNON | G11 Series |
| DALE | EB8 Series |
| ELCO | 6007 Series |
| SYLVANIA | AG Series |

## RECOMMENDED PROTOTYPE CONNECTOR

3M 3429-2002

**HEWLETT PACKARD**

# HIGH RESOLUTION OPTICAL REFLECTIVE SENSOR

# HEDS-1000

TECHNICAL DATA FEBRUARY 198

## Features

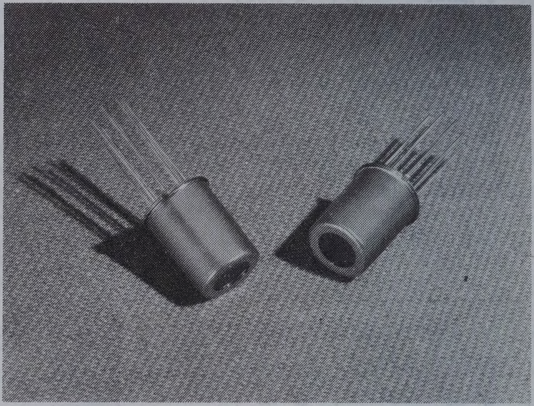
- FOCUSED EMITTER AND DETECTOR IN A SINGLE PACKAGE
- HIGH RESOLUTION — .190mm SPOT SIZE
- 700nm VISIBLE EMITTER
- LENS FILTERED TO REJECT AMBIENT LIGHT
- TO-5 MINIATURE SEALED PACKAGE
- PHOTODIODE AND TRANSISTOR OUTPUT
- SOLID STATE RELIABILITY

## Description

The HEDS-1000 is a fully integrated module designed for optical reflective sensing. The module contains a .178mm (.007 in.) diameter 700nm visible LED emitter and a matched I.C. photodetector. A bifurcated aspheric lens is used to image the active areas of the emitter and the detector to a single spot 4.27mm (0.168 in.) in front of the package. The reflected signal can be sensed directly from the photodiode or through an internal transistor that can be configured as a high gain amplifier.

## Applications

Applications include pattern recognition and verification, object sizing, optical limit switching, tachometry, textile thread counting and defect detection, dimensional monitoring, line locating, mark, and bar code scanning, and paper edge detection.

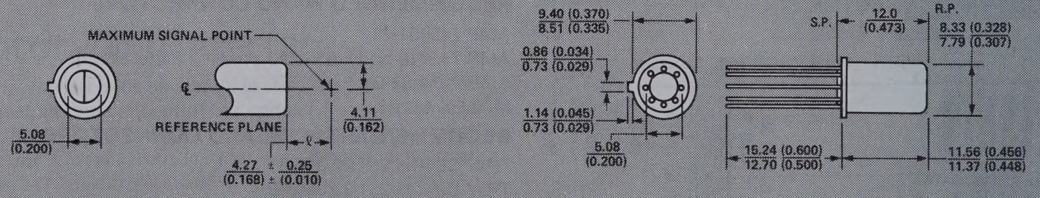


## Mechanical Considerations

The HEDS-1000 is packaged in a high profile 8 pin TO-5 metal can with a glass window. The emitter and photodetector chips are mounted on the header at the base of the package. Positioned above these active elements is a bifurcated aspheric acrylic lens that focuses them to the same point.

The sensor can be rigidly secured by commercially available two piece TO-5 style heat sinks, such as Thermalloy 2205, or Aavid Engineering 3215. These fixtures provide a stable reference platform and their tapped mounting holes allow for ease of affixing this assembly to the circuit board.

## Package Dimensions



NOTES:
1. ALL DIMENSIONS IN MILLIMETERS AND (INCHES).
2. ALL UNTOLERANCED DIMENSIONS ARE FOR REFERENCE ONLY.
3. THE REFERENCE PLANE IS THE TOP SURFACE OF THE PACKAGE.
4. NICKEL CAN AND GOLD PLATED LEADS.
5. S.P. SEATING PLANE.
6. THE LEAD DIAMETER IS 0.45mm (0.018in.) TYP.

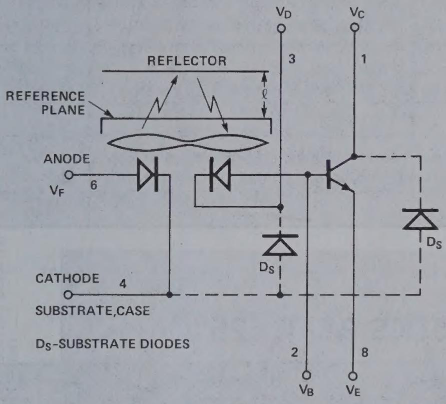
## Electrical Operation

The detector section of the sensor can be connected as a single photodiode, or as a photodiode transistor amplifier. When photodiode operation is desired, it is recommended that the substrate diodes be defeated by connecting the collector of the transistor to the positive potential of the power supply and shorting the base-emitter junction of the transistor. Figure 15 shows photocurrent being supplied from the anode of the photodiode to an inverting input of the operational amplifier. The circuit is recommended to improve the reflected photocurrent to stray photocurrent ratio by keeping the substrate diodes from acting as photodiodes.

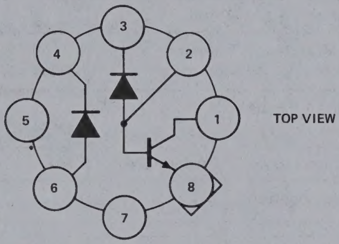
The cathode of the 700nm emitter is physically and electrically connected to the case-substrate of the device. Applications that require modulation or switching of the LED should be designed to have the cathode connected to the electrical ground of the system. This insures minimum capacitive coupling of the switching transients through the substrate diodes to the detector amplifier section.

The HEDS-1000 detector also includes an NPN transistor which can be used to increase the output current of the sensor. A current feedback amplifier as shown in Figure 6 provides moderate current gain and bias point stability.

SCHEMATIC DIAGRAM



CONNECTION DIAGRAM



| PIN | FUNCTION |
|---|---|
| 1 | TRANSISTOR COLLECTOR |
| 2 | TRANSISTOR BASE, PHOTODIODE ANODE |
| 3 | PHOTODIODE CATHODE |
| 4 | LED CATHODE, SUBSTRATE, CASE |
| 5 | NC |
| 6 | LED ANODE |
| 7 | NC |
| 8 | TRANSISTOR EMITTER |

## Absolute Maximum Ratings at $T_A$=25°C

| Parameter | Symbol | Min. | Max. | Units | Fig. | Notes |
|---|---|---|---|---|---|---|
| Storage Temperature | $T_S$ | -40 | +75 | °C | | |
| Operating Temperature | $T_A$ | -20 | +70 | °C | | |
| Lead Soldering Temperature 1.6mm from Seating Plane | | | 260 for 10 sec. | °C | | 11 |
| Average LED Forward Current | $I_F$ | | 50 | mA | | 2 |
| Peak LED Forward Current | $I_{FPK}$ | | 75 | mA | 1 | 1 |
| Reverse LED Input Voltage | $V_R$ | | 5 | V | | |
| Package Power Dissipation | $P_P$ | | 120 | mW | | 3 |
| Collector Output Current | $I_O$ | | 8 | mA | | |
| Supply and Output Voltage | $V_D$,$V_C$,$V_E$ | -0.5 | 20 | V | | 10 |
| Transistor Base Current | $I_B$ | | 5 | mA | | |
| Transistor Emitter Base Voltage | $V_{EB}$ | | .5 | V | | |

CAUTION: The small junction sizes inherent to the design of this bipolar component increase the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be introduced by ESD.

## System Electrical/Optical Characteristics at $T_A=25°C$

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Total Photocurrent ($I_{PR}+I_{PS}$) | $I_P$ | | | 375 | nA | $T_A=-20°C$ | $I_F=35mA$, $V_D=V_C=5V$ | | 4 |
| | | 100 | 180 | 250 | | $T_A=25°C$ | | 2,3 | |
| | | 50 | | | | $T_A=70°C$ | | 15 | |
| Reflected Photocurrent ($I_{PR}$) to Internal Stray Photocurrent ($I_{PS}$) | $\frac{I_{PR}}{I_{PS}}$ | 4 | 8.5 | | | $I_F=35mA$, $V_C=V_D=5V$ | | 3 | |
| Transistor DC Static Current Transfer Ratio | $h_{FE}$ | 50 | | | | $T_A=-20°C$ | $V_{CE}=5V$, $I_C=10\mu A$ | 4,5 | |
| | | 100 | 200 | | | $T_A=25°C$ | | | |
| Slew Rate | | | .08 | | V/µs | $R_L=100K$ $I_{PK}=50mA$<br>$R_F=10M$ $t_{ON}=100\mu s$, Rate = 1kHz | | 6 | |
| Image Diameter | d | | .17 | | mm | $I_F=35mA$, $\ell=4.27mm$ (0.168in.) | | 8,10 | 8,9 |
| Maximum Signal Point | $\ell$ | 4.02 | 4.27 | 4.52 | mm | Measured from Reference Plane | | 9 | |
| 50% Modulation Transfer Function | MTF | | 2.5 | | lnpr/mm | $I_F=35mA$, $\ell=4.27mm$ | | 10,11 | 5,7 |
| Depth of Focus | $\Delta\ell$ FWHM | | 1.2 | | mm | 50% of $I_P$ at $\ell=4.27mm$ | | 9 | 5 |
| Effective Numerical Aperature | N.A. | | .3 | | | | | | |
| Image Location | D | | .51 | | mm | Diameter Reference to Centerline $\ell=4.27mm$ | | | 6 |
| Thermal Resistance | $\Theta_{JC}$ | | 85 | | °C/W | | | | |

## Detector Electrical/Optical Characteristics at $T_A=25°C$

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Dark Current | $I_{PD}$ | | 5 | 120 | pA | $T_A=25°C$ | $I_F=0$, $V_D=5V$; Reflection=0% | | |
| | | | | 10 | nA | $T_A=70°C$ | | | |
| Capacitance | $C_D$ | | 45 | | pF | $V_D=0V$, $I_P=0$, f=1MHz | | | |
| Flux Responsivity | $R_\phi$ | | .22 | | $\frac{A}{W}$ | $\lambda=700nm$, $V_D=5V$ | | 12 | |
| Detector Area | $A_D$ | | .160 | | $mm^2$ | Square, with Length=.4mm/Side | | | |

## Emitter Electrical/Optical Characteristics at $T_A=25°C$

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.6 | 1.8 | V | $I_F=35mA$ | 13 | |
| Reverse Breakdown Voltage | $BV_R$ | 5 | | | V | $I_R=100\mu A$ | | |
| Radiant Flux | $\phi_E$ | 5 | 9.0 | | µW | $I_F=35mA$, $\lambda=700nm$ | 14 | |
| Peak Wavelength | $\lambda_P$ | 680 | 700 | 720 | nm | $I_F=35mA$ | 14 | |
| Thermal Resistance | $\Theta_{JC}$ | | 150 | | °C/W | | | |
| Temperature Coefficient of $V_F$ | $\Delta V_F/\Delta T$ | | -1.2 | | mV/°C | $I_F=35mA$ | | |

# Transistor Electrical Characteristics at $T_A = 25°C$

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Collector-Emitter Leakage | $I_{CEO}$ | | 1 | | pA | $V_{CE}=5V$ | | |
| Base-Emitter Voltage | $V_{BE}$ | | .6 | | V | $I_C=10\mu A$, $I_B=70nA$ | | |
| Collector-Emitter Saturation Voltage | $V_{CE}(SAT)$ | | .4 | | V | $I_B=1\mu A$, $I_E=10\mu A$ | | |
| Collector-Base Capacitance | $C_{CB}$ | | .3 | | pF | f=1MHz, $V_{CB}=5V$ | | |
| Base-Emitter Capacitance | $C_{BE}$ | | .4 | | pF | f=1MHz, $V_{BE}=0V$ | | |
| Thermal Resistance | $\Theta_{JC}$ | | 200 | | °C/W | | | |

NOTES:

1. 300μs pulse width, 1 kHz pulse rate.
2. Derate Maximum Average Current linearly from 65°C by 6mA/°C.
3. Without heat sinking from $T_A = 65°C$, derate Maximum Average Power linearly by 12mW/°C.
4. Measured from a reflector coated with a 99% reflective white paint (Kodak 6080) positioned 4.27mm (0.168 in.) from the reference plane.
5. Peak-to-Peak response to black and white bar patterns.
6. Center of maximum signal point image lies within a circle of diameter D relative to the center line of the package. A second emitter image (through the detector lens) is also visible. This image does not affect normal operation.
7. This measurement is made with the lens cusp parallel to the black-white transition.
8. Image size is defined as the distance for the 10%-90% response as the sensor moves over an abrupt black-white edge.
9. (+) indicates an increase in the distance from the reflector to the reference plane.
10. All voltages referenced to Pin 4.
11. CAUTION: The thermal constraints of the acrylic lens will not permit the use of conventional wave soldering procedures. The typical preheat and post cleaning temperatures and dwell times can subject the lens to thermal stresses beyond the absolute maximum ratings and can cause it to defocus.

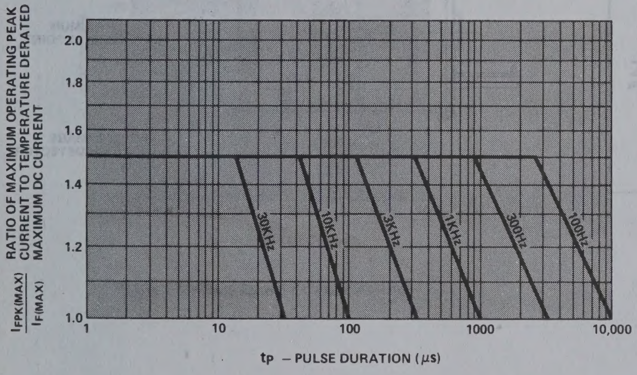


**Figure 1. Maximum Tolerable Peak Current vs. Pulse Duration**

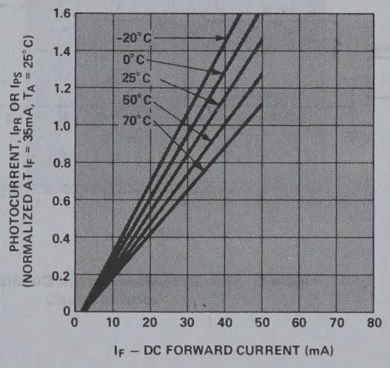
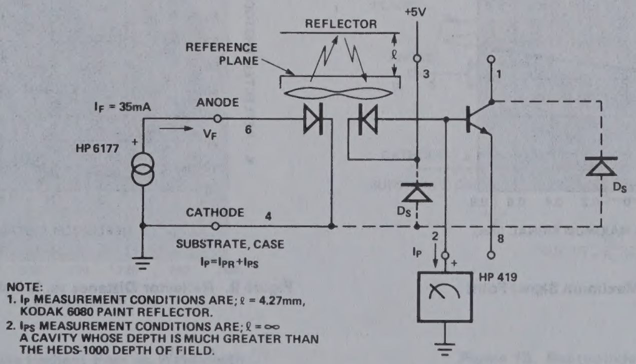


**Figure 2. Relative Total Photocurrent vs. LED DC Forward Current**



NOTE:
1. $I_P$ MEASUREMENT CONDITIONS ARE; ℓ = 4.27mm, KODAK 6080 PAINT REFLECTOR.
2. $I_{PS}$ MEASUREMENT CONDITIONS ARE; ℓ = ∞ A CAVITY WHOSE DEPTH IS MUCH GREATER THAN THE HEDS-1000 DEPTH OF FIELD.

**Figure 3. Ip Test Circuit**

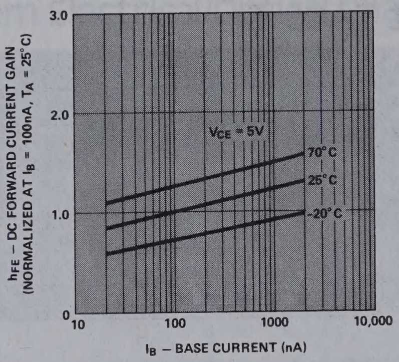


**Figure 4. Normalized Transistor DC Forward Current Gain vs. Base Current at Temperature**

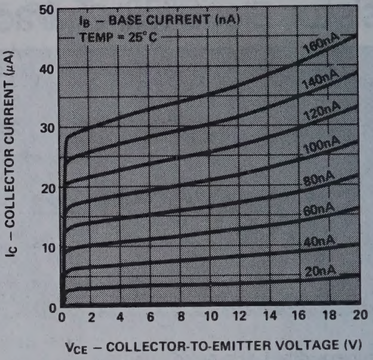


**Figure 5. Common Emitter Collector Characteristics**

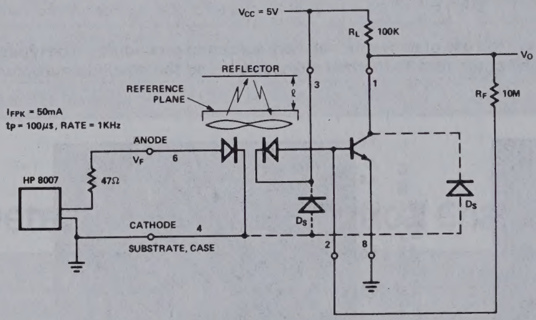

$V_{CC}$ = 5V
$R_L$
100K
$V_O$
REFLECTOR
REFERENCE PLANE
ℓ
3
1
$R_F$
10M
$I_{FPK}$ = 50mA
tp = 100µs, RATE = 1KHz
ANODE
$V_F$
6
HP 8007
47Ω
$D_S$
$D_S$
CATHODE
4
SUBSTRATE, CASE
2
8

**Figure 6. Slew Rate Measurement Circuit**

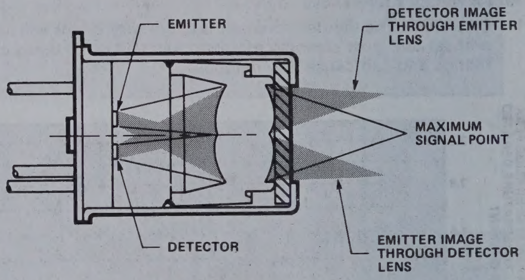

EMITTER
DETECTOR IMAGE THROUGH EMITTER LENS
MAXIMUM SIGNAL POINT
DETECTOR
EMITTER IMAGE THROUGH DETECTOR LENS

**Figure 7. Image Location**

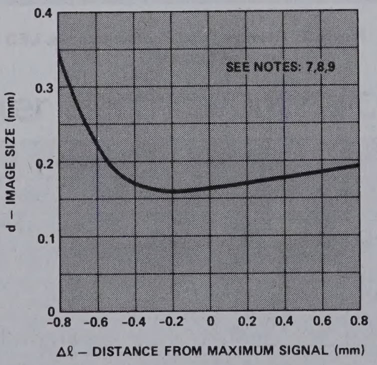


**Figure 8. Image Size vs. Maximum Signal Point**

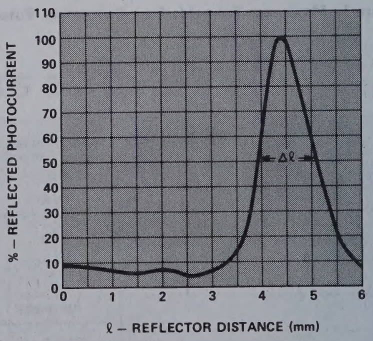


**Figure 9. Reflector Distance vs. % Reflected Photocurrent**

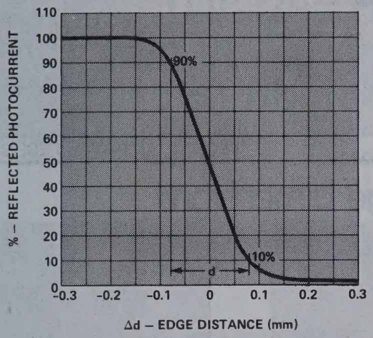


Figure 10. Step Edge Response

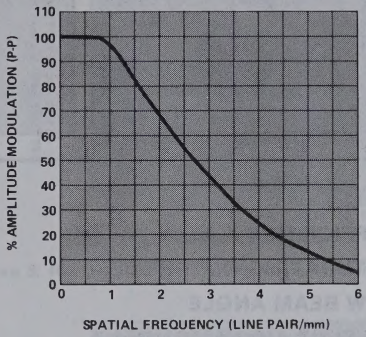


Figure 11. Modulation Transfer Function

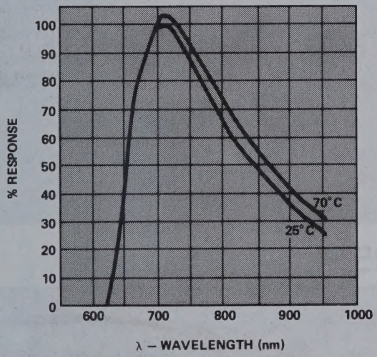


Figure 12. Detector Spectral Response

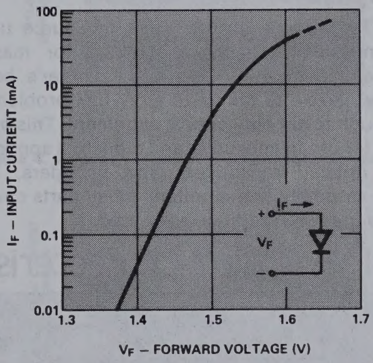


Figure 13. LED Forward Current vs. Forward Voltage Characteristics

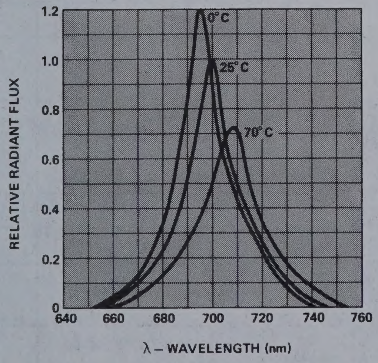


Figure 14. Relative Radiant Flux vs. Wavelength

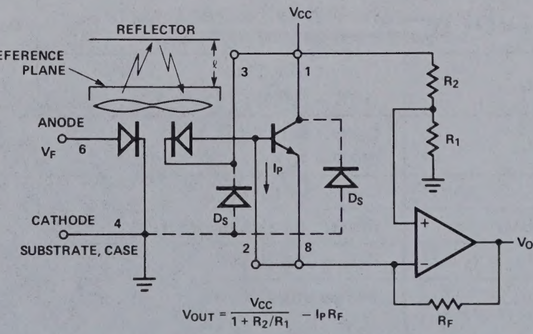

$V_{CC}$
REFLECTOR
REFERENCE PLANE
ℓ
3
1
$R_2$
$R_1$
ANODE
$V_F$
6
$I_P$
$D_S$
$D_S$
CATHODE
4
SUBSTRATE, CASE
2
8
+
–
$V_{OUT}$
$R_F$
$V_{OUT} = \frac{V_{CC}}{1 + R_2/R_1} - I_P R_F$

Figure 15. Photodiode Interconnection

HEWLETT PACKARD

# 670nm HIGH RADIANT INTENSITY EMITTER

# HEMT-3300

TECHNICAL DATA FEBRUARY 1982

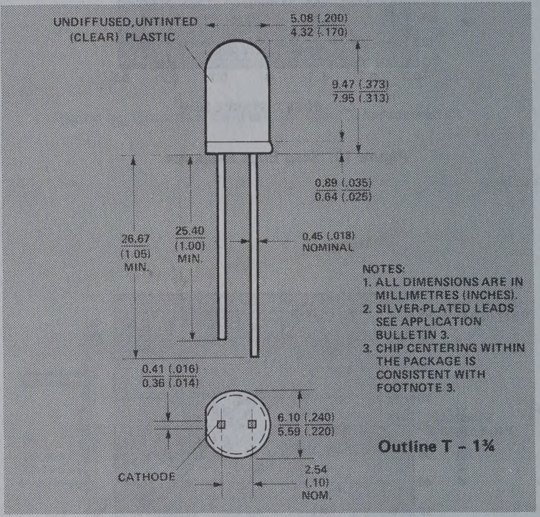
## Features

- HIGH EFFICIENCY
- NONSATURATING OUTPUT
- NARROW BEAM ANGLE
- VISIBLE FLUX AIDS ALIGNMENT
- BANDWIDTH: DC TO 3 MHz
- IC COMPATIBLE/LOW CURRENT REQUIREMENT

## Description

The HEMT-3300 is a visible, near-IR, source using a GaAsP on GaP LED chip optimized for maximum quantum efficiency at 670 nm. The emitter's beam is sufficiently narrow to minimize stray flux problems, yet broad enough to simplify optical alignment. This product is suitable for use in consumer and industrial applications such as optical transducers and encoders, smoke detectors, assembly line monitors, small parts counters, paper tape readers and fiber optic drivers.

## Package Dimensions



NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. SILVER-PLATED LEADS SEE APPLICATION BULLETIN 3.
3. CHIP CENTERING WITHIN THE PACKAGE IS CONSISTENT WITH FOOTNOTE 3.

**Outline T - 1¾**

## Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Description | Min. | Typ. | Max. | Units | Test Conditions | Figure |
|---|---|---|---|---|---|---|---|
| $I_e$ | Axial Radiant Intensity | 200 | 500 | | μW/sr | $I_F$ = 10 mA | 3,4 |
| $K_e$ | Temperature Coefficient of Intensity | | -0.009 | | °C⁻¹ | $I_F$ = 10 mA, Note 1 | |
| $\eta_V$ | Luminous Efficacy | | 22 | | lm/W | Note 2 | |
| $2\Theta_{1/2}$ | Half Intensity Total Angle | | 22 | | deg. | Note 3, $I_F$ = 10 mA | 6 |
| $\lambda_{PEAK}$ | Peak Wavelength | | 670 | | nm | Measured at Peak | 1 |
| $\Delta\lambda_{PEAK}/\Delta T$ | Spectral Shift Temperature Coefficient | | 0.089 | | nm/°C | Measured at Peak, Note 4 | |
| $t_r$ | Output Rise Time (10% – 90%) | | 120 | | ns | $I_{PEAK}$ = 10 mA | |
| $t_f$ | Output Fall Time (90% – 10%) | | 50 | | ns | $I_{PEAK}$ = 10 mA Pulse | |
| $C_o$ | Capacitance | | 15 | | pF | $V_F$ = 0; f = 1 MHz | |
| $BV_R$ | Reverse Breakdown Voltage | 5.0 | | | V | $I_R$ = 100 μA | |
| $V_F$ | Forward Voltage | | 1.9 | 2.5 | V | $I_F$ = 10 mA | 2 |
| $\Delta V_F/\Delta T$ | Temperature Coefficient of $V_F$ | | -2.2 | | mV/°C | $I_F$ = 100 μA | |
| $\Theta_{JC}$ | Thermal Resistance | | 160 | | °C/W | Junction to cathode lead at seating plane. | |

Notes: 1. $I_e(T) = I_e(25°C)\exp[K_e(T - 25°C)]$ 2. $I_V = \eta_V I_e$ where $I_V$ is in candela, $I_e$ in watts/steradian and $\eta_V$ in lumen/watt.
3. $\Theta_{1/2}$ is the off-axis angle at which the radiant intensity is half the axial intensity. The deviation between the mechanical and optical axis is typically within a conical half-angle of five degrees. 4. $\lambda_{PEAK}(T) = \lambda_{PEAK}(25°C) + (\Delta\lambda_{PEAK}/\Delta T)(T - 25°C)$.

# Maximum Ratings at $T_A = 25°C$

Power Dissipation ........................ 120 mW
(derate linearly from 50°C at 1.6 mW/°C)
Average Forward Current .................... 30 mA
(derate linearly from 50°C at 0.4 mA/°C)
Peak Forward Current .................. See Figure 5
Operating and Storage
Temperature Range ............... -55°C to +100°C
Lead Soldering Temperature .......... 260°C for 5 sec.
(1.6 mm [0.063 inch] from body)

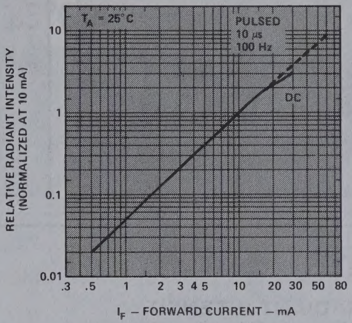


**Figure 3. Relative Radiant Intensity versus Forward Current.**

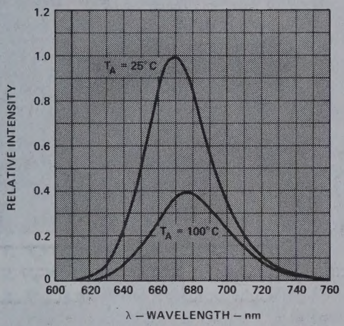


**Figure 1. Relative Intensity versus Wavelength.**

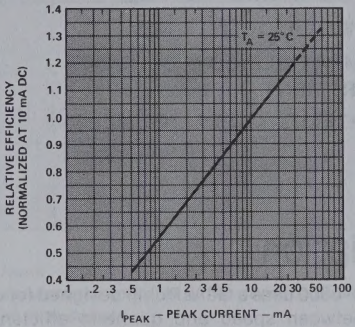


**Figure 4. Relative Efficiency (Radiant Intensity per Unit Current) versus Peak Current.**

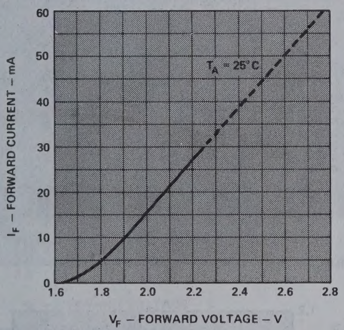


**Figure 2. Forward Current versus Forward Voltage.**

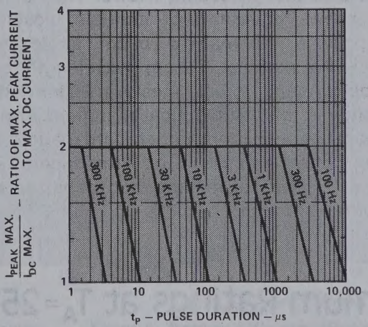


**Figure 5. Maximum Tolerable Peak Current versus Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

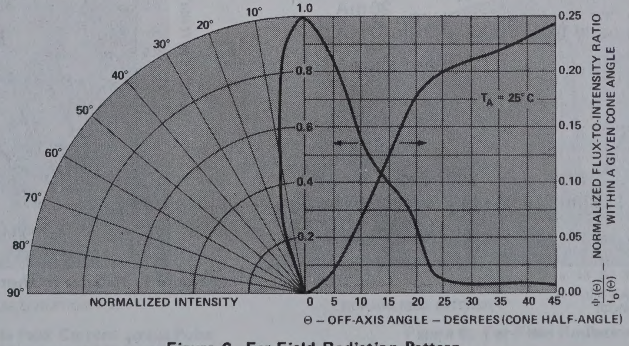


**Figure 6. Far-Field Radiation Pattern.**

HEWLETT PACKARD

# 700nm HIGH INTENSITY SUBMINIATURE EMITTER

# HEMT-6000

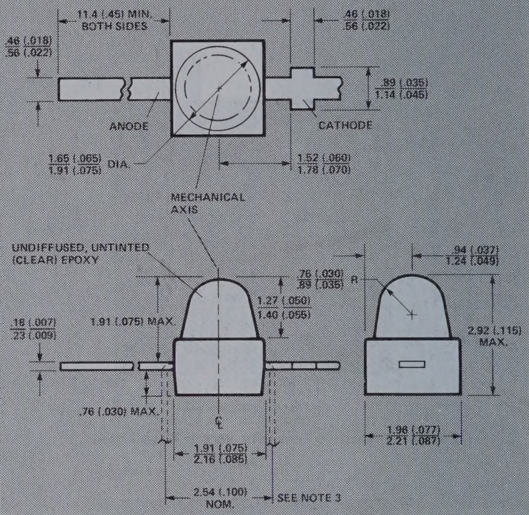
TECHNICAL DATA FEBRUARY 1982

## Features

- HIGH RADIANT INTENSITY
- NARROW BEAM ANGLE
- NONSATURATING OUTPUT
- BANDWIDTH: DC TO 5 MHz
- IC COMPATIBLE/LOW CURRENT REQUIREMENT
- VISIBLE FLUX AIDS ALIGNMENT

## Description

The HEMT-6000 uses a GaAsP chip designed for optimum tradeoff between speed and quantum efficiency. This optimization allows a flat modulation bandwidth of 5 MHz without peaking, yet provides a radiant flux level comparable to that of 900nm IREDs. The subminiature package allows operation of multiple closely-spaced channels, while the narrow beam angle minimizes crosstalk. The nominal 700nm wavelength can offer spectral performance advantages over 900nm IREDs, and is sufficiently visible to aid optical alignment. Applications include paper-tape readers, punch-card readers, bar code scanners, optical encoders or transducers, interrupt modules, safety interlocks, tape loop stabilizers and fiber optic drivers.


11.4 (.45) MIN. BOTH SIDES
.46 (.018)
.56 (.022)
.46 (.018)
.56 (.022)
.89 (.035)
1.14 (.045)
ANODE
CATHODE
1.65 (.065)
1.91 (.075) DIA.
1.52 (.060)
1.78 (.070)
MECHANICAL AXIS
UNDIFFUSED, UNTINTED (CLEAR) EPOXY
.76 (.030)
.89 (.035) R
.94 (.037)
1.24 (.049)
1.27 (.050)
1.40 (.055)
.18 (.007)
.23 (.009)
1.91 (.075) MAX.
2.92 (.115) MAX.
.76 (.030) MAX.
℄
1.91 (.075)
2.16 (.085)
1.96 (.077)
2.21 (.087)
2.54 (.100) NOM.
SEE NOTE 3

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. SILVER-PLATED LEADS. SEE APPLICATION BULLETIN 3.
3. USER MAY BEND LEADS AS SHOWN.
4. EPOXY ENCAPSULANT HAS A REFRACTIVE INDEX OF 1.53.
5. CHIP CENTERING WITHIN THE PACKAGE IS CONSISTENT WITH FOOTNOTE 3.

## Maximum Ratings at $T_A = 25°C$

Power Dissipation .......................... 50 mW
(derate linearly from 70°C @ 1.0mW/°C)

Average Forward Current .................... 20 mA
(derate linearly from 70°C @ 0.4mA/°C)

Peak Forward Current .................. See Figure 5

Operating and Storage
Temperature Range ................ -55° to +100°C

Lead Soldering
Temperature ..................... 260°C for 5 sec.
[1.6 mm (0.063 in.) from body]

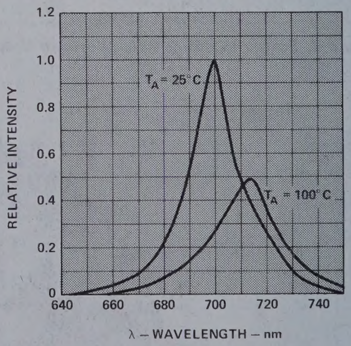


**Figure 1. Relative Intensity versus Wavelength.**

# Electrical/Optical Characteristics at $T_A = 25°C$

| Symbol | Description | Min. | Typ. | Max. | Units | Test Conditions | Fig. |
|---|---|---|---|---|---|---|---|
| $I_e$ | Radiant Intensity along Mechanical Axis | 100 | 250 | | μW/sr | $I_F$ = 10 mA | 3,4 |
| $K_e$ | Temperature Coefficient of Intensity | | -0.005 | | $°C^{-1}$ | Note 1 | |
| $\eta_v$ | Luminous Efficacy | | 2.5 | | lm/W | Note 2 | |
| $2\Theta_{1/2}$ | Optical Axis Half Intensity Total Angle | | 16 | | deg. | Note 3, $I_F$ = 10 mA | 6 |
| $\lambda_{PEAK}$ | Peak Wavelength (Range) | | 690-715 | | nm | Measured @ Peak | 1 |
| $\Delta\lambda_{PEAK}/\Delta T$ | Spectral Shift Temperature Coefficient | | .193 | | nm/°C | Measured @ Peak, Note 4 | |
| $t_r$ | Output Rise Time (10%-90%) | | 70 | | ns | $I_{PEAK}$ = 10 mA | |
| $t_f$ | Output Fall Time (90%-10%) | | 40 | | ns | $I_{PEAK}$ = 10 mA | |
| $C_o$ | Capacitance | | 65 | | pF | $V_F$ = 0; f = 1 MHz | |
| $BV_R$ | Reverse Breakdown Voltage | 5 | 12 | | V | $I_R$ = 100 μA | |
| $V_F$ | Forward Voltage | | 1.5 | 1.8 | V | $I_F$ = 10 mA | 2 |
| $\Delta V_F/\Delta T$ | Temperature Coefficient of $V_F$ | | -2.1 | | mV/°C | $I_F$ = 100 μA | |
| $\Theta_{JC}$ | Thermal Resistance | | 140 | | °C/W | Junction to cathode lead at 0.79 mm (.031 in) from body | |

NOTES:
1. $I_e(T) = I_e(25°C) \exp[K_e(T - 25°C)]$.
2. $I_v = \eta_v I_e$ where $I_v$ is in candela, $I_e$ in watts/steradian, and $\eta_v$ in lumen/watt.
3. $\Theta_{1/2}$ is the off-axis angle at which the radiant intensity is half the intensity along the optical axis. The deviation between the mechanical and the optical axis is typically within a conical half-angle of three degrees.
4. $\lambda_{PEAK}(T) = \lambda_{PEAK}(25°C) + (\Delta\lambda_{PEAK}/\Delta T)(T - 25°C)$

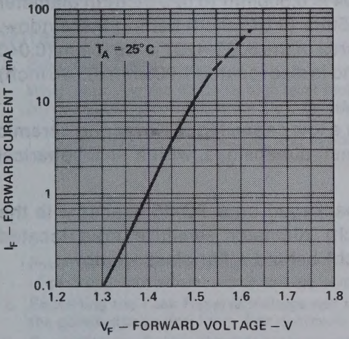


**Figure 2. Forward Current versus Forward Voltage.**

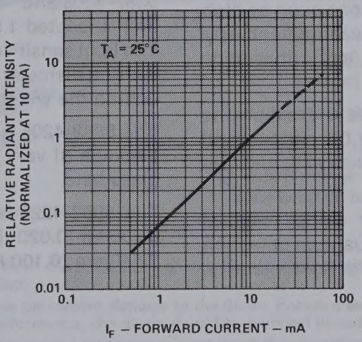


**Figure 3. Relative Radiant Intensity versus Forward Current.**

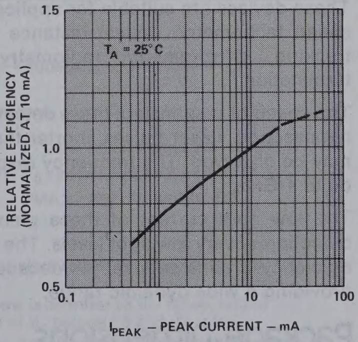


**Figure 4. Relative Efficiency (Radiant Intensity per Unit Current) versus Peak Current.**

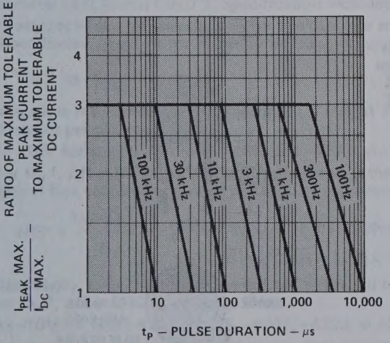


**Figure 5. Maximum Tolerable Peak Current versus Pulse Duration. ($I_{DC}$ MAX as per MAX Ratings)**

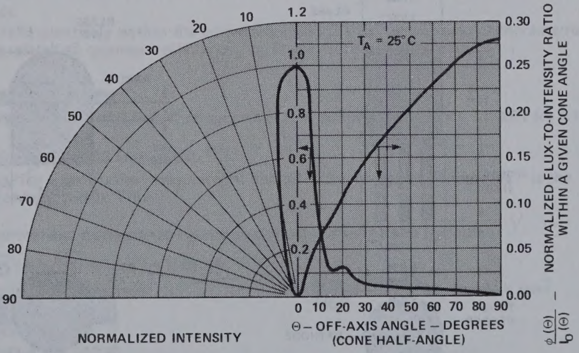


**Figure 6. Far-Field Radiation Pattern.**

HEWLETT PACKARD

# PIN PHOTODIODES

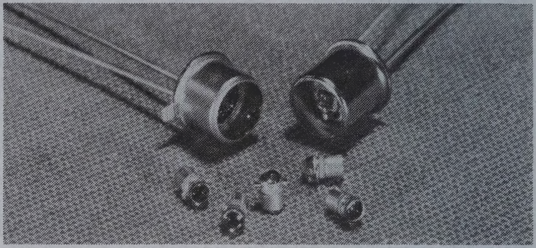
# 5082-4200 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- HIGH SENSITIVITY (NEP <-108 dBm)
- WIDE DYNAMIC RANGE (1% LINEARITY OVER 100 dB)
- BROAD SPECTRAL RESPONSE
- HIGH SPEED ($T_r$, $T_f$,<1ns)
- STABILITY SUITABLE FOR PHOTOMETRY/ RADIOMETRY
- HIGH RELIABILITY
- FLOATING, SHIELDED CONSTRUCTION
- LOW CAPACITANCE
- LOW NOISE

**Active area: 1mm Diam 5082-4207 — TALL SIZE (TO-18)**
**5082-4203**
**0.5mm Diam 5082-4204**
**5082-4220 — Short (TO-46)**
**0.25mm Magnified 2.5x 5082-4205 — Subminiature**



## Description

The HP silicon planar PIN photodiodes are ultra-fast light detectors for visible and near infrared radiation. Their response to blue and violet is unusually good for low dark current silicon photodiodes.

These devices are suitable for applications such as high speed tachometry, optical distance measurement, star tracking, densitometry, radiometry, and fiber-optic termination.

The speed of response of these detectors is less than one nanosecond. Laser pulses shorter than 0.1 nanosecond may be observed. The frequency response extends from dc to 1 GHz.

The low dark current of these planar diodes enables detection of very low light levels. The quantum detection efficiency is constant over ten decades of light intensity, providing a wide dynamic range.

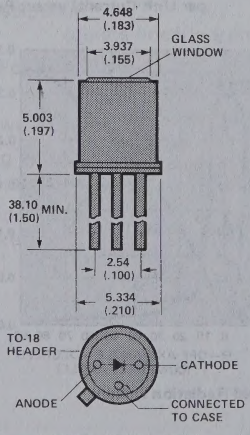
The 5082-4203, -4204, and -4207 are packaged on a standard TO-18 header with a flat glass window cap. For versatility of circuit connection, they are electrically insulated from the header. The light sensitive area of the 5082-4203 and -4204 is 0.508mm (0.020 inch) in diameter and is located 1.905mm (0.075 inch) behind the window. The light sensitive area of the 5082-4207 is 1.016mm (0.040 inch) in diameter and is also located 1.905mm (0.075 inch) behind the window.

The 5082-4205 is in a low capacitance Kovar and ceramic package of very small dimensions, with a hemispherical glass lens.

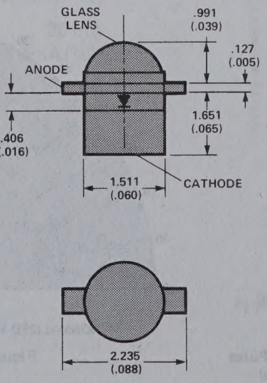
The 5082-4220 is packaged on a TO-46 header with the 0.508mm(0.020 inch) diameter sensitive area located 2.540mm (0.100 inch) behind a flat glass window.

## Package Dimensions

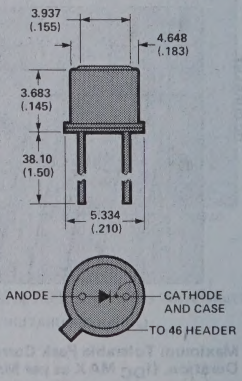
DIMENSIONS IN MILLIMETRES (INCHES)


4.648
(.183)
3.937
(.155)
GLASS
WINDOW
5.003
(.197)
38.10
(1.50)
MIN.
2.54
(.100)
5.334
(.210)
TO-18
HEADER
CATHODE
ANODE
CONNECTED
TO CASE

-4203, -4204, -4207


GLASS
LENS
.991
(.039)
.127
(.005)
ANODE
.406
(.016)
1.651
(.065)
1.511
(.060)
CATHODE
2.235
(.088)

-4205


3.937
(.155)
4.648
(.183)
3.683
(.145)
38.10
(1.50)
5.334
(.210)
ANODE
CATHODE
AND CASE
TO 46 HEADER

-4220

## Absolute Maximum Ratings Operating and Storage Temperature –55° to 125°C

| Parameter | -4203 | -4204 | -4205 | -4207 | -4220 | Units |
|---|---|---|---|---|---|---|
| $P_{MAX}$ Power Dissipation 1 | 100 | 100 | 50 | 100 | 100 | mW |
| Steady Reverse Voltage 3 | 50 | 20 | 50 | 20 | 50 | volts |

## Electrical/Optical Characteristics at $T_A = 25°C$

| | | -4203 | | | -4204 | | | -4205 | | | -4207 | | | -4220 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Symbol | Description | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Min. | Typ. | Max. | Units |
| $R_E, 0 = R_\phi \cdot A$ | Axial Incidance Response at 770nm [4] | | 1.0 | | | 1.0 | | | 1.5* | | | 4.0 | | | 1.0 | | $\frac{\mu A}{mW/cm^{2}}$ |
| A | Active Area 4 | | $2 \times 10^{-3}$ | | | $2 \times 10^{-3}$ | | | $3 \times 10^{-3}$* | | | $8 \times 10^{-3}$ | | | $2 \times 10^{-3}$ | | $cm^{2}$ |
| $R_\phi$ | Flux Responsivity 770 nm 5 (Fig. 1, 3) | | .5 | | | .5 | | | .5 | | | .5 | | | .5 | | $\frac{\mu A}{\mu W}$ |
| $I_D$ | Dark Current 6 (Fig. 4) | | | 2.0 | | | 0.6 | | | .15 | | | 2.5 | | | 5.0 | nA |
| NEP | Noise Equivalent Power 7 (Fig. 8) | | | $5.1 \times 10^{-14}$ | | | $2.8 \times 10^{-14}$ | | | $1.4 \times 10^{-14}$ | | | $5.7 \times 10^{-14}$ | | | $8.1 \times 10^{-14}$ | $\frac{W}{\sqrt{Hz}}$ |
| D* | Detectivity 8 | $8.7 \times 10^{11}$ | | | $1.6 \times 10^{12}$ | | | $4.0 \times$* $10^{12}$ | | | $1.5 \times 10^{12}$ | | | $5.6 \times 10^{11}$ | | | $\frac{cm\sqrt{Hz}}{W}$ |
| $C_j$ | Junction Capacitance 9 (Fig. 5) | | 1.5 | | | 2.0 | | | 0.7 | | | 5.5 | | | 2.0 | | pF |
| $C_P$ | Package Capacitance 10 | | 2 | | | 2 | | | | | | 2 | | | | | pF |
| $t_r, t_f$ | Zero Bias Speed (Rise, Fall Time) 11 | | 300 | | | 300 | | | 300 | | | 300 | | | 300 | | ns |
| $t_r, t_f$ | Rev.–Bias Speed (Rise, Fall Time) 12 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | ns |
| $R_S$ | Series Resistance | | | 50 | | | 50 | | | 50 | | | 50 | | | 50 | Ω |

*see Note 4.

NOTES:

1. Peak Pulse Power

   When exposing the diode to high level incidance the following photocurrent limits must be observed:

   $$I_p \text{ (avg MAX.)} < \frac{P_{MAX} - P_\phi}{E_c}\text{; and in addition:}$$

   $$I_{p(PEAK)} < \frac{1000\ A}{t\ (\mu sec)} \text{ or } < 500mA \text{ or } < \frac{I_p \text{ (avg MAX.)}}{f \times t}$$

   whichever of the above three conditions is least.

   $I_p$ - photocurrent (A) f - pulse repetion rate (MHz)
   $E_c$ - supply voltage (V) $P_\phi$ - power input via photon flux
   t - pulse duration (μs) $P_{MAX}$ - max dissipation (W)

   Power dissipation limits apply to the sum of both the optical power input to the device and the electrical power input from flow of photocurrent when reverse voltage is applied.
2. Exceeding the Peak Reverse Voltage will cause permanent damage to the diode. Forward current is harmless to the diode, within the power dissipation limit. For optimum performance, the diode should be reversed biased with $E_c$ between 5 and 20 volts.
3. Exceeding the Steady Reverse Voltage may impair the low-noise properties of the photodiodes, an effect which is noticeable only if operation is diode-noise limited (see Figure 8).
4. The 5082-4205 has a lens with approximately 2.5x magnification; the actual junction area is $0.5 \times 10^{-3}$ cm$^2$, corresponding to a diameter of 0.25mm (.010"). Specification includes lens effect.
5. At any particular wavelength and for the flux in a small spot falling entirely within the active area, responsivity is the ratio of incremental photodiode current to the incremental flux producing it. It is related to quantum efficiency, $\eta_q$ in electrons per photon by:

   $$R_\phi = \eta_q \left(\frac{\lambda}{1240}\right)$$

   where λ is the wavelength in nanometers. Thus, at 770nm, a responsivity of 0.5 A/W corresponds to a quantum efficiency of 0.81 (or 81%) electrons per photon.
6. At –10V for the 5082-4204, –4205, and –4207; at –25V for the 5082-4203 and –4220.
7. For (λ, f, Δf) = (770nm, 100Hz, 6Hz) where f is the frequency for a spot noise measurement and Δf is the noise bandwidth, NEP is the optical flux required for unity signal/noise ratio normalized for bandwidth. Thus:

   $$NEP = \frac{I_N/\sqrt{\Delta f}}{R_\phi}$$ where $I_N/\sqrt{\Delta f}$ is the bandwidth — normalized noise current computed from the shot noise formula:

   $$I_N/\sqrt{\Delta f} = \sqrt{2qI_D} = 17.9 \times 10^{-15} \sqrt{I_D}\ (A/\sqrt{Hz})$$ where $I_D$ is in nA.
8. Detectivity, D* is the active-area-normalized signal to noise ratio. It is computed: $$D^* = \frac{\sqrt{A}}{NEP} \left(\frac{cm\sqrt{Hz}}{W}\right)$$ for A in cm$^2$, for (λ, f, Δf) = (770nm, 100Hz, 6Hz).
9. At –10V for 5082-4204, –4205, –4207, –4220; at –25V for 5082-4203.
10. Between diode cathode lead and case — does not apply to 5082-4205, -4220.
11. With 50Ω load.
12. With 50Ω load and –20V bias.

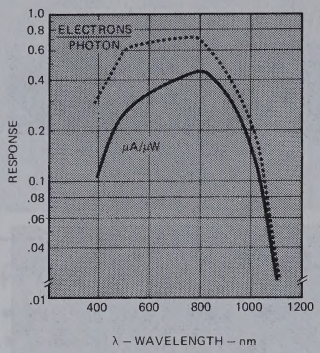


**Figure 1. Spectral Response.**

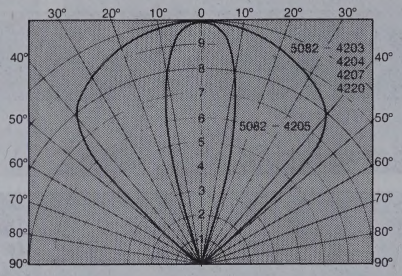


**Figure 2. Relative Directional Sensitivity of the PIN Photodiodes.**

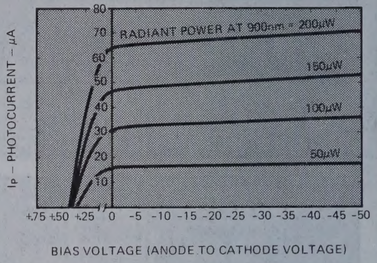


**Figure 3. Typical Output Characteristics at λ = 900nm.**

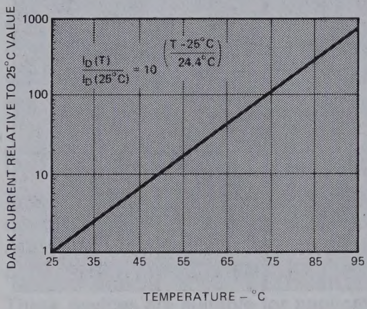


**Figure 4. Dark Current at -10V Bias vs. Temperature.**

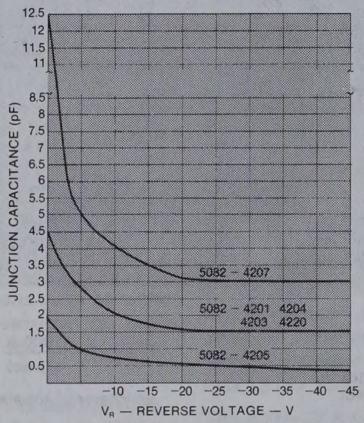


**Figure 5. Typical Capacitance Variation With Applied Voltage.**

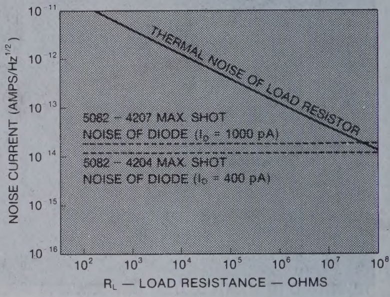


**Figure 6. Noise vs. Load Resistance.**

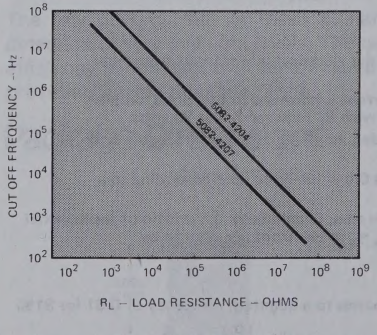


**Figure 7. Photodiode Cut-Off Frequency vs. Load Resistance (C = 2pF).**

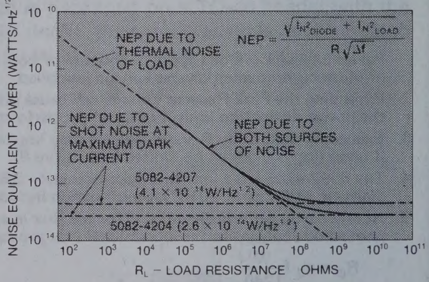


**Figure 8. Noise Equivalent Power vs. Load Resistance.**

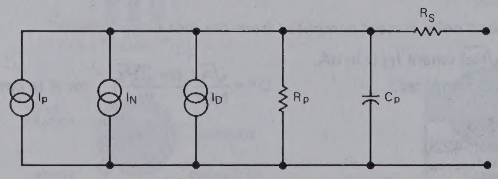


**Figure 9. Photodiode Equivalent Circuit.**

$I_P$=Signal current ≈ 0.5μA/μW x flux input at 770 nm
$I_N$= Shot noise current
<$1.2 \times 10^{-14}$ amps/Hz$^{1/2}$(5082-4204)
<$4 \times 10^{-14}$ amps/Hz$^{1/2}$(5082-4207)
$I_D$= Dark current
<$600 \times 10^{-12}$ amps at -10 V dc (5082-4204)
<$2500 \times 10^{-12}$ amps at -10 V dc (5032-4207)
$R_P$ = 1011Ω
$R_S$ = <50Ω

# Application Information

## NOISE FREE PROPERTIES

The noise current of the PIN diodes is negligible. This is a direct result of the exceptionally low leakage current, in accordance with the shot noise formula $I_N = (2qI_R\Delta f)^{1/2}$. Since the leakage current does not exceed 600 picoamps for the 5082-4204 at a reverse bias of 10 volts, shot noise current is less than $1.4 \times 10^{-14}$ amp $Hz^{-1/2}$ at this voltage.

Excess noise is also very low, appearing only at frequencies below 10 Hz, and varying approximately as 1/f. When the output of the diode is observed in a load, thermal noise of the load resistance ($R_L$) is $1.28 \times 10^{-10}$ $(R_L)^{-1/2} \times (\Delta f)^{1/2}$ at 25° C, and far exceeds the diode shot noise for load resistance less than 100 megohms (see Figure 6). Thus in high frequency operation where low values of load resistance are required for high cut-off frequency, all PIN photodiodes contribute virtually no noise to the system (see Figures 6 and 7).

## HIGH SPEED PROPERTIES

Ultra-fast operation is possible because the HP PIN photodiodes are capable of a response time less than one nanosecond. A significant advantage of this device is that the speed of response is exhibited at relatively low reverse bias (−10 to −20 volts).

## OFF-AXIS INCIDANCE RESPONSE

Response of the photodiodes to a uniform field of radiant incidance $E_e$, parallel to the polar axis is given by $I = (RA) \times E_e$ for 770nm. The response from a field not parallel to the axis can be found by multiplying (RA) by a normalizing factor obtained from the radiation pattern at the angle of operation. For example, the multiplying factor for the 5082-4207 with incidance $E_e$ at an angle of 40° from the polar axis is 0.8. If $E_e = 1 mW/cm^2$, then $I_p = k \times (RA) \times E_e$; $I_p = 0.8 \times 4.0 \times 1 = 3.2$ μamps.

## SPECTRAL RESPONSE

To obtain the response at a wavelength other than 770nm, the relative spectral response must be considered. Referring to the spectral response curve, Figure 1, obtain response, X, at the wavelength desired. Then the ratio of the response at the desired wavelength to response at 770nm is given by:

$$\text{RATIO} = \frac{X}{0.5}$$

Multiplying this ratio by the incidance response at 770nm gives the incidance response at the desired wavelength.

## ULTRAVIOLET RESPONSE

Under reverse bias, a region around the outside edge of the nominal active area becomes responsive. The width of this annular ring is approximately 25μm (0.001 inch) at −20V, and expands with higher reverse voltage. Responsivity in this edge region is higher than in the interior, particularly at shorter wavelengths; at 400nm the interior, responsivity is 0.1 A/W while edge responsivity is 0.35 A/W. At wavelengths shorter than 400nm, attenuation by the glass window affects response adversely. Speed of response for edge incidance is $t_r$, $t_f \approx 300$ns.

## 5082-4205 MOUNTING RECOMMENDATIONS

a. The 5082-4205 is intended to be soldered to a printed circuit board having a thickness of from 0.51 to 1.52mm (0.02 to 0.06 inch).

b. Soldering temperature should be controlled so that at no time does the case temperature approach 280° C. The lowest solder melting point in the device is 280° C (gold-tin eutectic). If this temperature is approached, the solder will soften, and the lens may fall off. Lead-tin solder is recommended for mounting the package, and should be applied with a small soldering iron, for the shortest possible time, to avoid the temperature approaching 280° C.

c. Contact to the lens end should be made by soldering to one or both of the tabs provided. Care should be exercised to prevent solder from coming in contact with the lens.

d. If printed circuit board mounting is not convenient, wire leads may be soldering or welded to the devices using the precautions noted above.

## LINEAR OPERATION

Having an equivalent circuit as shown in Figure 9, operation of the photodiode is most linear when operated with a current amplifier as shown in Figure 10.

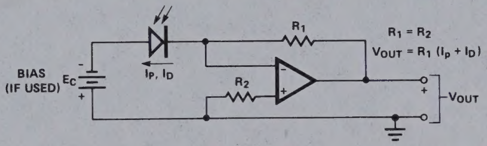


Figure 10. Linear Operation.

Lowest noise is obtained with $E_c = 0$, but higher speed and wider dynamic range are obtained if $5 < E_c < 20$ volts. The amplifier should have as high an input resistance as possible to permit high loop gain. If the photodiode is reversed, bias should also be reversed.

## LOGARITHMIC OPERATION

If the photodiode is operated at zero bias with a very high impedance amplifier, the output voltage will be:

$$V_{OUT} = (1 + \frac{R_2}{R_1}) \cdot \frac{kT}{q} \cdot \ln \quad (1 + \frac{I_P}{I_S})$$

where $I_S = I_F \ (e^{\frac{qV}{kT}} - 1)^{-1}$ at $0 < I_F < 0.1mA$

using a circuit as shown in Figure 11.

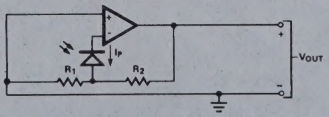
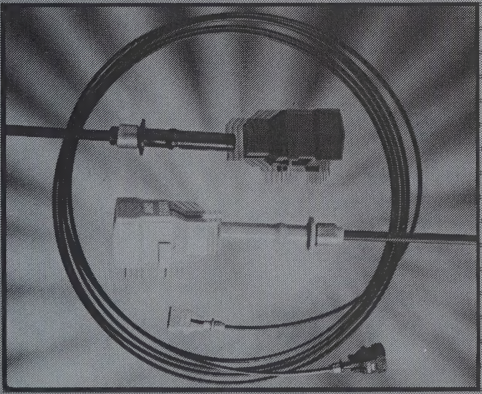


Figure 11. Logarithmic Operation.

Output voltage, $V_{OUT}$, is positive as the photocurrent, $I_P$, flows back through the photodiode making the anode positive.

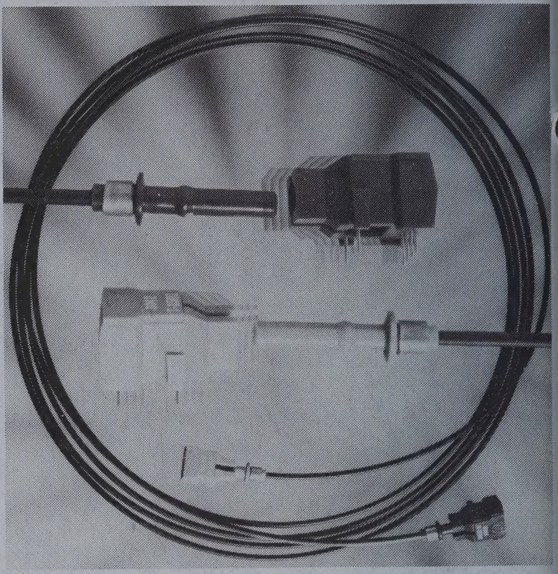
# Fiber Optics

- Introduction .................. 284
- Selection Guide ............. 287
- Snap-in Fiber Optic Kit
- Miniature Fiber Optic Logic Link
- Transmitters
- Receivers
- Cables
- Connector Assembly Tooling Kit



# Fiber Optics!

Hewlett-Packard offers a wide range of fiber optic transmitter and receiver components, fiber optic cable connectors, fiber optic cable, connector assembly tools for field installation and repair of fiber/cable connectors and supporting technical literature. Special care is taken to guarantee that all of the individual pieces of the complete fiber optic data links function together as a system over life and temperature range. This insures ease-of-operation for first time users and no "tweaking" assembly for high volume production requirements.

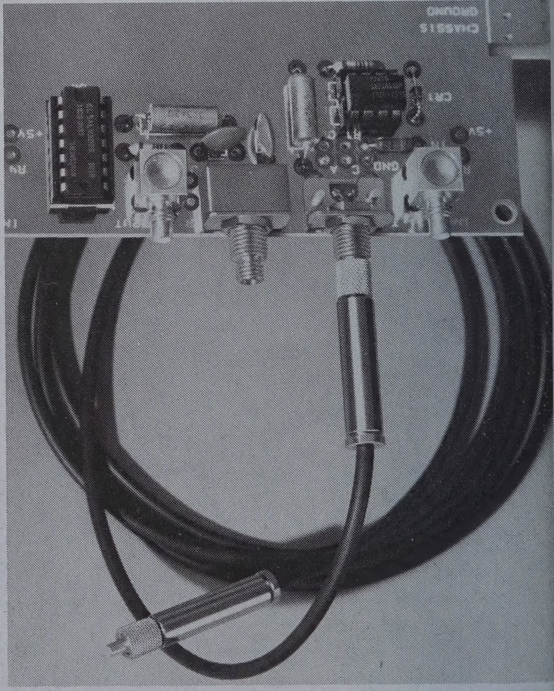


HFBR-0500

## Snap-In Fiber Optic Link

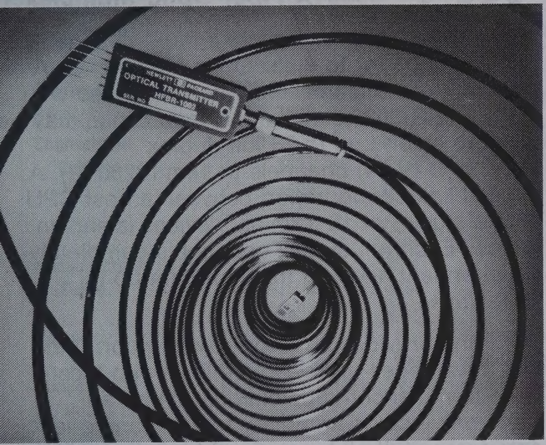
The Snap-in Fiber Optic Link is a low cost, dc to 5 Mbaud, digital data transmission link. It can be used for 0.1 to 18 metre inter- or intra-system data links, solving common mode or high voltage isolation problems. Electromagnetic compatibility (EMC) specifications and safety requirements of the FCC or VDE can be met through the use of the Snap-in Fiber Optic Link. The product family includes transmitter, receiver, connectors, and plastic fiber optic cable, all of which are specified for operation from 0° C to 70° C. The HFBR-0500 evaluation kit offers the first time user a complete guaranteed link with 5 metres of connectored cable and technical literature. Also included are two extra connectors and a fiber polishing kit. All components of the Snap-in Fiber Optic Link family including connectored or unconnectored fiber cable, are available separately.

miniature
fiber optic logic link
HEWLETT PACKARD
HEWLETT PACKARD
HEWLETT PACKARD



HFBR-0200

*HFBR-1002*



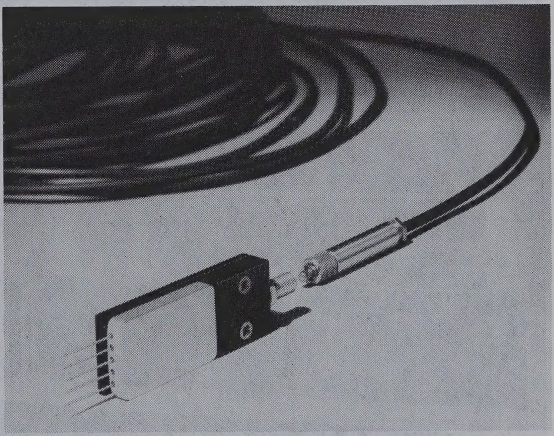
**NEW PRODUCT**

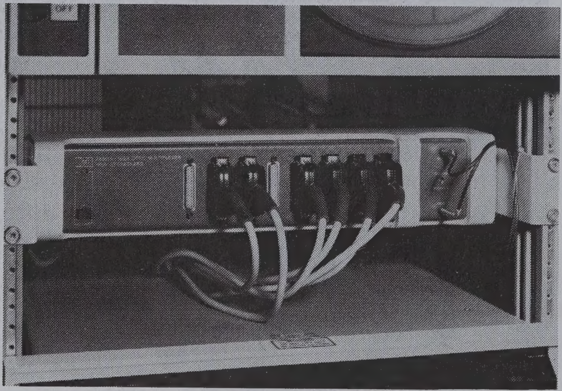
### Miniature Fiber Optic Logic Link

The Miniature Fiber Optic Logic Link is capable of dc to 5 Mbaud data transmission over lengths of 500 metres minimum and 1200 metres typical with use of 100/140$\mu$m glass clad silica (GCS) fiber optic cables. The miniature metal packaged T/R's can be mounted on an instrument back panel, PC board or bulkhead. An evaluation kit, the HFBR-0200, containing a transmitter, receiver, 10m of connectored cable, mounting hardware and technical literature is available. Separate T/R's fiber/cable connectors and customer specified fiber/cable lengths with or without factory installed connectors are also available. The HFBR-0100 Connector Assembly Kit allows field installation of fiber/cable connectors.

### High-Performance Modules

Hewlett-Packard offers two systems, with guaranteed performance, for link lengths of up to 100 and 1000 metres. These systems use 100/140 $\mu$m glass clad silica fiber optic cables, accept any data format from dc to 10 Mbaud, and include a built-in link monitor. The transmitter and receiver contain all circuitry for complete TTL compatibility and require only 5V power supplies. To make it easy to get started, HP offers the HFBR-0010, a complete 10 metre simplex link, consisting of the 100m transmitter module, receiver module, 10 metres of connectored fiber/cable and technical literature. Separate T/Rs, fiber/cable connectors and customer specified fiber/cable lengths, with or without factory installed connectors, are also available. The HFBR-0100 Connector Assembly Kit allows field installation of fiber/cable connectors.





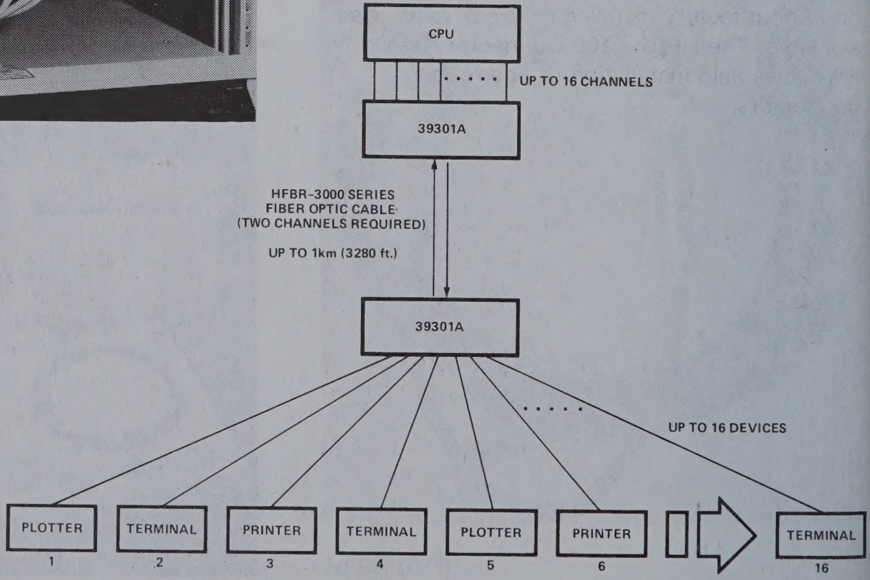
**NEW PRODUCT**

## New Product — 39301A Fiber Optic Multiplexer

Hewlett-Packard now offers a multi-channel RS-RS-232-C (V.24) to Fiber Optic Multiplexer. A pair of these multiplexers, interconnected with HP's HFBR-3000 series fiber optic cable, may be used to extend up to 16 full duplex RS-232-C (V.24) channels to 1km (3280 ft.). A typical link configuration between a host CPU and a cluster of 16 terminal devices is shown below. Each full duplex channel is completely independent and can transmit data up to 19.2 Kbps.

This link provides an easy way to incorporate the advantages of fiber optic links into local area terminal communications. These advantages include immunity to electromagnetic interference of all types, from lightning strikes to noisy electric motors, and freedom from static discharge and crosstalk. The fiber optic cable also provides security for data as it will not radiate electromagnetic signals. In volatile atmospheres, there is no need for special cable shielding because no sparks can be generated by this totally dielectric medium.

For more information, contact your local Hewlett-Packard Components Field Engineer, or write Hewlett-Packard Optoelectronics Division. 640 Page Mill Road, Palo Alto, California, 94304.


CPU
UP TO 16 CHANNELS
39301A
HFBR-3000 SERIES
FIBER OPTIC CABLE
(TWO CHANNELS REQUIRED)
UP TO 1km (3280 ft.)
39301A
UP TO 16 DEVICES
PLOTTER
1
TERMINAL
2
PRINTER
3
TERMINAL
4
PLOTTER
5
PRINTER
6
TERMINAL
16

# Fiber Optic Selection Guide

| Product | Part No. | Length | Data Rate | Fiber | Connector | Input/ Output | Page No. |
|---|---|---|---|---|---|---|---|
| **Snap In-Link** | | 18m | 5 MBaud | 1000 µm Plastic | Plastic | LED/TTL | 286 |
| Trial Kit | HFBR-0500 | | | | | | |
| Transmitter | HFBR-1500/01 | | | | | | |
| Receiver | HFBR-2500 | | | | | | |
| Connectored Cable | HFBR-3500 | OPT 001 | Customer specified length, Simplex | | | | |
| | HFBR-3501 | 0.1m | | | | | |
| | HFBR-3502 | 0.5m | | | | | |
| | HFBR-3503 | 1.0m | | | | | |
| | HFBR-3504 | 5.0m | | | | | |
| Unconnectored Cable | HFBR-3589 | 25m | | | | | |
| | HFBR-3590 | 100m | | | | | |
| | HFBR-3591 | 500m | | | | | |
| Connectors | HFBR-4501 | Gray Plastic Connector and Crimp Ring for Transmitter | | | | | |
| | HFBR-4511 | Blue Plastic Connector and Crimp Ring for Receiver | | | | | |
| Connector Polishing Fixture | HFBR-4595 | Polishing fixture and abrasive paper for HFBR-4501/11 Connectors | | | | | |
| **Miniature Logic Link** | | 500m | 5 MBaud | 100/140 µm GCS | Metal | LED/TTL | 295 |
| Trial Kit | HFBR-0200 | | | | | | |
| Transmitter | HFBR-1201 | | | | | | |
| Receiver | HFBR-2201 | | | | | | |
| Connectored Cable | HFBR-3000 | OPT 001 | Customer specified length, Simplex | | | | 315 |
| | HFBR-3100 | OPT 001 | Customer specified length, Duplex | | | | 317 |
| Unconnectored Cable | HFBR-3200 | OPT 001 | Customer specified length, Simplex | | | | 319 |
| | HFBR-3300 | OPT 001 | Customer specified length, Duplex | | | | |
| Connectors | HFBR-4000 | 100/140 µm Metal Ferrule | | | | | 322 |
| | HFBR-3099 | Connector – Connector Junction, Panel Mount Bulkhead Feed-through for HFBR-4000 Connector | | | | | |
| Connector Assembly Tools | HFBR-0100 | Field installation kit for HFBR-4000 Connectors (includes case, tools, consumables) | | | | | 324 |
| | HFBR-0101 | Replacement consumables for HFBR-0100 kit | | | | | |
| | HFBR-0102 | Custom tool set only | | | | | |
| Mounting Hardware | HFBR-4201 | PCB Mounting bracket/ EMI/ESD shield, miscellaneous hardware | | | | | 295 |
| **High Performance Modules** | | | 10 MBaud | 100/140 µm GCS | Metal | TTL/TTL | 283 |
| Trial Kit | HFBR-0010 | | | | | | |
| Transmitter | HFBR-1001 | (100m) | | | | | 303 |
| | HFBR-1002 | (1000m) | | | | | 307 |
| Receiver | HFBR-2001 | | | | | | 311 |
| Connectored Cable | HFBR-3000 | OPT 001 | Customer specified length, Simplex | | | | 315 |
| | HFBR-3100 | OPT 001 | Customer specified length, Duplex | | | | 317 |
| Unconnectored Cable | HFBR-3200 | OPT 001 | Customer specified length, Simplex | | | | 319 |
| | HFBR-3300 | OPT 001 | Customer specified length, Duplex | | | | |
| Connectors | HFBR-4000 | 100/140 µm Metal Ferrule | | | | | 322 |
| | HFBR-3099 | Connector – Connector Junction, Panel Mount Bulkhead Feed through for HFBR-4000 Connector | | | | | |
| Connector Assembly Tools | HFBR-0100 | Field installation kit for HFBR-4000 Connectors (includes case, tools, consumables) | | | | | 324 |
| | HFBR-0101 | Replacement consumables for HFBR-0100 kit | | | | | |
| | HFBR-0102 | Custom tool set only | | | | | |
| **RS-232-C/V.24 To Fiber Optic Multiplexer** | | | | | | | |
| Multiplexer | 39301A | 1000m | 19.2kbps/ channel | 100/140 µm GCS | Metal | RS-232-C/ RS-232-C | Not in Catalog |

HEWLETT PACKARD

# SNAP-IN FIBER OPTIC LINK

## HFBR-0500 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- LOW COST PLASTIC DUAL-IN-LINE PACKAGE
- SNAP-IN CONNECTOR
- OPTIMIZED FOR PLASTIC CABLE
- EASY FIELD TERMINATIONS
- SHIELDED DETECTOR STAGE FOR HIGH NOISE IMMUNITY
- OPERATION TO 5 METRES*
- DC TO 5 MBaud DATA RATE
- LSTTL/TTL COMPATIBLE OUTPUT LEVEL
- CHOICE OF INTERNAL PULL-UP OR OPEN COLLECTOR OUTPUT
- STANDARD OR SPECIAL LENGTH CABLES
- SINGLE +5V RECEIVER POWER SUPPLY
- COLOR CODED TRANSMITTER AND RECEIVER

## Applications

- EMC REGULATED SYSTEMS (FCC, VDE)
- INTER/INTRA-SYSTEM DATA LINK
- STATIC PROTECTION
- HIGH VOLTAGE ISOLATION
- MEDICAL EQUIPMENT
- SECURE DATA COMMUNICATIONS

*For link lengths up to 18m see the HFBR-0500 series addendum on page 295. Link lengths up to 32m are possible using specially selected components — contact your local Hewlett-Packard sales office.

snap-in
fiber optic link
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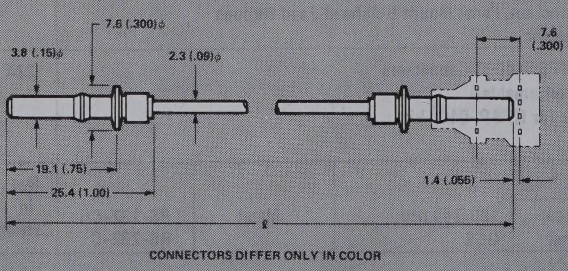
## Description

The HFBR-0500 series is a dc to 5 MBaud short distance plastic fiber optic digital data transmission link available in discrete link lengths. The system includes a transmitter, receiver, and a plastic fiber optic cable guaranteed to operate at link lengths up to 5 metres. The modules have been designed to accommodate the snap-in connector on the plastic cable. The HFBR-0500 series Fiber Optic Link can be used for low cost, short length inter- or intra-system data links, solving common mode or high voltage isolation problems. The link may also be used to solve Electromagnetic Compatibility (EMC) specifications and safety requirements of the FCC or VDE.

The gray plastic HFBR-1500/1 Transmitter incorporates a 665 nm LED and can easily be interfaced to logic families with a current driver integrated circuit buffer. The blue

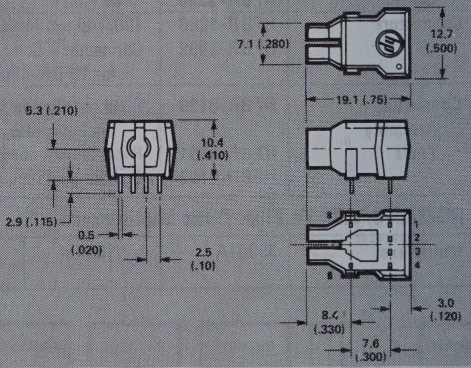
## Mechanical Dimensions

HFBR-4501/4511 CONNECTOR


7.6 (.300)ϕ
3.8 (.15)ϕ
2.3 (.09)ϕ
7.6 (.300)
19.1 (.75)
25.4 (1.00)
1.4 (.055)
ℓ

CONNECTORS DIFFER ONLY IN COLOR

HFBR-1500/2500 MODULE


7.1 (.280)
12.7 (.500)
19.1 (.75)
5.3 (.210)
10.4 (.410)
2.9 (.115)
0.5 (.020)
2.5 (.10)
8
1
2
3
4
5
8.4 (.330)
3.0 (.120)
7.6 (.300)

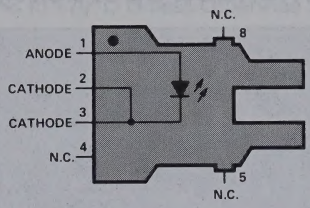
DIMENSIONS IN mm (inches)
ALL DIMENSIONS ± 0.1 mm

plastic HFBR-2500 Receiver module incorporates an integrated photo detector and wide bandwidth dc amplifier. A Schottky clamped open collector output transistor with optional internal pull-up resistor provides an output compatible with most +5V logic families, and provides the capability for bussing, strobing, or wired "-OR" connection. The use of an internal shield covering the sensitive circuit elements of the receiver allows this device to be used in high EMI applications.

The HFBR-3500 1 mm core plastic Fiber Optic Cable is terminated in color coded snap-in plastic connectors. Terminated lengths of cable are available in 0.1 metre increments and may be purchased separately from the transmitter and receiver modules. Bulk lengths of unconnectored cable (HFBR-3590) can easily be terminated with the HFBR-4501 (gray)/HFBR-4511 (blue) connectors and a crimp tool,* then finished with the HFBR-4595 Polishing Kit.

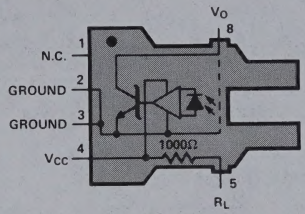
*AMP crimp tool #90364-1 or #69876

### HFBR-1500/1501 TRANSMITTER



TOP VIEW

### HFBR-2500 RECEIVER



TOP VIEW

## Absolute Maximum Ratings

| Parameter | | Symbol | Min. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| **LINK** | | | | | | |
| Storage Temperature | | $T_S$ | -40 | +75 | °C | |
| Operating Temperature | | $T_A$ | 0 | +70 | °C | |
| Lead Soldering Cycle | Temp | | | 260 | °C | 1 |
| | Time | | | 10 | sec | |
| **TRANSMITTER** | | | | | | |
| Peak Forward Input Current | | $I_{F\,PK}$ | | 500 | mA | 2 |
| Average Forward Input Current | | $I_{F\,AV}$ | | 80 | mA | |
| Reverse Input Voltage | | $V_{BR}$ | | 5 | V | |
| **RECEIVER** | | | | | | |
| Supply Voltage | | $V_{CC}$ | -0.5 | 7 | V | |
| Output Current | | $I_O$ | | 25 | mA | |
| Output Collector Power Dissipation | | $P_{OD}$ | | 40 | mW | |
| Output Voltage | | $V_O$ | -0.5 | 7 | V | |
| **CABLE** | | | | | | |
| Tensile Force | Cable | $F_T$ | | 50 | N | 3 |
| | Cable/Connector | $F_T$ | | 5 | N | 3 |
| Bend Radius | | r | 10 | | mm | 4 |
| Flexing | | | | 1000 | Cycles | 6 |
| Impact | | m | | 1 | Kg | 7 |
| | | h | | 15 | mm | |

# Recommended Operating Conditions

| Parameter | | Symbol | Min. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| **LINK** | | | | | | |
| Ambient Temperature | | $T_A$ | 0 | 70 | °C | |
| Transmission Distance | | ℓ | 0.1 | 5 | m | Figure 2 |
| **TRANSMITTER** | | | | | | |
| Peak Forward Input Current | Diode ON | $I_{F\ (ON)}$ | | 60 | mA | |
| | Diode OFF | $I_{F\ (OFF)}$ | | 250 | μA | |
| **RECEIVER** | | | | | | |
| Supply Voltage | | $V_{CC}$ | 4.75 | 5.25 | V | 13 |
| Fan Out (TTL) | | N | | 5 | | 8 |
| Receiver Input Flux for Logic "0" | | $\phi_R$ (L) | 8.0 | 56 | μW | 11,14 |
| | | | -21.0 | -12.5 | dBm | |
| Receiver Input Flux for Logic "1" | | $\phi_R$ (H) | | 0.05 | μW | 11,14 |
| | | | | -43 | dBm | |
| **CABLE** | | | | | | |
| Long Term Bend Radius | | r | 35 | | mm | 5 |
| Long Term Tensile Load | | $F_T$ | | 1 | N | 5 |

# Electrical/Optical Characteristics

0° C to 70° C Unless Otherwise Specified

| Parameter | | Symbol | Min | Typ(12) | Max | Units | Conditions | Note |
|---|---|---|---|---|---|---|---|---|
| **LINK** | | | | | | | | |
| Receiver EMI Immunity | | | | 8000 | | V/m | RF = 1 MHz, BER = $10^{-9}$,<br>ℓ = 5 m | 14 |
| Propagation Delay Low to High Output Level | | $t_{PLH}$ | | 75 | 140 | nsec | ℓ = 0.5 m, $I_F$ = 20 mA<br>HFBR-1501<br>$R_L$ = 560 Ω, $C_L$ = 15 pF | 9 |
| Propagation Delay High to Low Output Level | | $t_{PHL}$ | | 75 | 140 | nsec | ℓ = 0.5 m, $I_F$ = 20 mA<br>HFBR-1501<br>$R_L$ = 560 Ω, $C_L$ = 15 pF | 9 |
| **TRANSMITTER** | | | | | | | | |
| Transmitter Output Optical Flux | HFBR-1500 | $\phi_T$ | 24.0 | 80 | 105 | μW | $I_F$ = 60 mA | 10,16 |
| | | | -16.2 | -11 | -9.8 | dBm | | |
| | HFBR-1501 | | 33.1 | 101 | 144 | μW | | |
| | | | -14.8 | -9.9 | -8.4 | dBm | | |
| Peak Emission Wavelength | | $\lambda_{PK}$ | | 665 | | nm | | |
| Forward Voltage | | $V_F$ | 1.45 | 1.67 | 2.02 | V | $I_F$ = 60 mA | |
| Forward Voltage Temperature Coefficient | | $\Delta V_F/\Delta T$ | | -1.37 | | mV/°C | | |
| Effective Diameter | | $D_T$ | | 1 | | mm | | |
| Numerical Aperture | | N.A. | | 0.5 | | | | |
| Reverse Input Voltage | | $V_{BR}$ | 5.0 | 12.4 | | V | $I_F$ = -10 μA $T_A$ = 25°C | |
| Diode Capacitance | | $C_O$ | | 86 | | pF | $V_F$ = 0, f = 1 MHz | |
| Transmitter Propagation Delay Low Level to High Output | | $t_{PLHT}$ | | 20 | | nsec | $I_F$ = 20 mA, ℓ = 0.5 m | 9 |
| Transmitter Propagation Delay High Level to Low Output | | $t_{PHLT}$ | | 5 | | nsec | $I_F$ = 20 mA, ℓ = 0.5 m | 9 |

## Electrical/Optical Characteristics (Cont.) 0° C to +70° C Unless Otherwise Specified

| Parameter | Symbol | Min. | Typ.(12) | Max. | Units | Conditions | Note |
|---|---|---|---|---|---|---|---|
| **RECEIVER** | | | | | | | |
| Input Flux Level for Logic "0" | $\phi_R$ (L) | 8.0 | | 56 | μW | HFBR-1500/1501 Source | 11,16 |
| | | -21.0 | | -12.5 | dBm | $V_{OL} = 0.5V$, $I_{OL} = 8$ mA | |
| Input Flux Level for Logic "1" | $\phi_R$ (H) | | | 0.05 | μW | HFBR-1500/1501 Source | 11 |
| | | | | -43 | dBm | $V_{OH} = 5.25V$, $I_{OH} \leq 250$ μA | |
| High Level Output Current | $I_{OH}$ | | 5 | 250 | μA | $V_O = 5.25V$, $\phi_R = 0.05$ μW | |
| Low Level Output Voltage | $V_{OL}$ | | 0.4 | 0.5 | V | $\phi_R = 8.0$ μW, $I_{OL} = 8$ mA | |
| High Level Supply Current | $I_{CCH}$ | | 3.5 | 6.3 | mA | $V_{CC} = 5.25V$, $\phi_R = 0$ | |
| Low Level Supply Current | $I_{CCL}$ | | 6.2 | 10 | mA | $V_{CC} = 5.25V$, $\phi_R = 56$ μW<br>$R_L$ = Open | |
| Effective Diameter | $D_R$ | | 1 | | mm | | |
| Numerical Aperture | $N.A._R$ | | 0.5 | | | | |
| Internal Pull-Up Resistor | $R_L$ | | 1000 | | Ohms | | |
| Output Risetime 10-90% | $t_r$ | | 15 | | nsec | $V_{CC} = 5V$, $R_L = 560\Omega$, $C_L = 15$ pF | 9 |
| Output Falltime 10-90% | $t_f$ | | 15 | | nsec | | 9 |
| **CABLE** | | | | | | | |
| Link Coupling Variation | $\Delta\alpha_{LC}$ | | 0.9 | 2.0 | dB | | 15 |
| Cable Attenuation | $\alpha_O$ | 0.3 | 0.4 | 0.63 | dB/m | @ 665 nm Source NA = 0.5 | |
| Numerical Aperture | N.A. | | 0.5 | | | $\ell > 2$ m | |
| Diameter, Core | $D_C$ | | 1.0 | | mm | | |
| Diameter, Jacket | $D_J$ | | 2.2 | | mm | | |
| Delay | $t_{pdc}$ | | 4.5 | | nsec/m | | |
| Mass per Unit Length | $m/\ell$ | | 4.6 | | g/m | Without Connectors | |
| Cable Leakage Current | $I_L$ | | 1 | | nA | 10 kV, $\ell = 0.1$ m | |

Notes:

1. 1.6 mm below seating plane.
2. 1 μsec pulse; 20 μsec period.
3. Less than 30 minutes.
4. Less than 1 hour, non-operating.
5. Operating.
6. 90° bend on 10 mm mandrel.
7. 1 kg weight dropped from 15 mm on 25 mm mandrel laid over cable.
8. 8 mA load (5 x 1.6 mA).
9. See Figure 5.
10. Measured at the end of 0.5 m HFBR-3500 Fiber Optic Cable with large area detector.
11. Measured at the end of HFBR-3500 Fiber Optic Cable with large area detector.
12. Typical data at 25° C, $V_{CC}$ = 5V dc.
13. It is essential that a bypass capacitor (0.01 μF to 0.1 μF, ceramic) be connected from pin 3 to pin 4 of the receiver. Total lead length between both ends of the capacitor and the pins should not exceed 20 mm.
14. For 5 MBaud operation.
15. Included in $\phi_T$ and $\phi_R$.
16. When changing microwatts to dBm, the optical flux is referenced to one milliwatt (1000 μW).

$$\text{Optical Flux, } \phi \text{ (dBm)} = 10 \log \frac{\phi\ (\mu W)}{\phi_O}, \quad (\phi_O = 1000\ \mu W)$$

## Ordering Guide

HFBR-0500 Evaluation Kit:

- HFBR-1501 Transmitter (Gray)
- HFBR-2500 Receiver (Blue)
- HFBR-3504 5 metre Connectored Cable
- HFBR-4501 Connector/Crimp Ring (Gray)
- HFBR-4511 Connector/Crimp Ring (Blue)
- HFBR-4595 Polishing Kit
- Technical Literature

HFBR-4595 Polishing Kit:

- Polishing Fixture
- Abrasive Paper

Modules/Connectors:

| | |
|---|---|
| HFBR-1500/1501 | Transmitter Module — Gray |
| HFBR-2500 | Receiver Module — Blue |
| HFBR-4501 | Gray Connector/Crimp Ring |
| HFBR-4511 | Blue Connector/Crimp Ring |

### Connectored Plastic Fiber Optic Cable

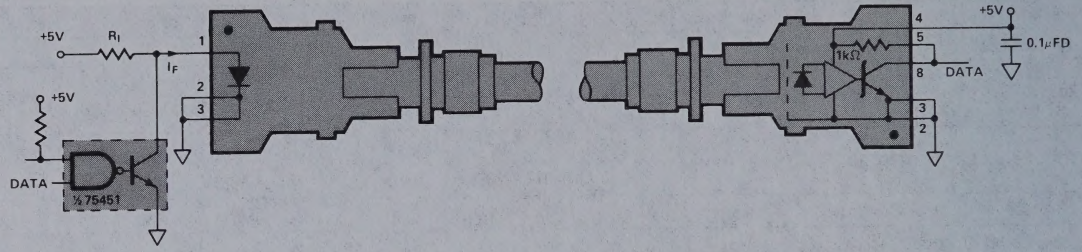
Customer Specified Cable Length:
HFBR-3500 Option 001 XX.X metres +10%, -0%

Stocked Cable Length:
HFBR-3501 — 0.1 metres
HFBR-3502 — 0.5 metres
HFBR-3503 — 1.0 metres
HFBR-3504 — 5.0 metres

### Unconnectored Plastic Fiber Optic Cable

HFBR-3589 — 25 metres
HFBR-3590 — 100 metres
HFBR-3591 — 500 metres

## Typical Circuit Configuration



## Electrical Description

The HFBR-1500/1 Fiber Optic Transmitter contains a 665 nm LED which has been optimized for use with the HFBR-3500 series plastic Fiber Optic Cable. The anode lead and two cathode leads of the emitting diode are available, allowing various drive circuit configurations.

Short fiber optic links requiring low emitter drive current can be easily interfaced to standard TTL logic with TTL buffers such as the 7407 or 7438. Longer distance data links requiring higher emitter drive currents may require a 75450 series high current buffer as the interface.

The HFBR-2500 Fiber Optic Receiver features an integrated photodetector and shielded wide bandwidth dc amplifier for high EMI immunity. The circuit has an open collector Schottky output transistor for high speed digital interfacing to common logic families, and enables "wired-OR" circuit designs. For convenience, an integrated 1000 ohm resistor internally connected to $V_{CC}$ may be externally jumpered to provide a pull-up to the power supply voltage for ease of use with +5V logic.

## Mechanical

The HFBR-3500 series plastic Fiber Optic Cable is terminated in color coded connectors which are secured to the cable with a crimp ring. The connectors have been designed to snap in the identically colored transmit and receive plastic modules. Compressive forces on the modules hold the connector in place and the tapered connector end assures alignment of the fiber with either the emitter or the detector active area.

When soldering the module, it is advisable to insert a connector in the module to keep the optics clean.

## Cable Termination

Connectors may easily be installed on the cable ends with readily available tools. Materials needed for the terminating procedure are:

1. HFBR-3590 Fiber Optic Cable
2. HFBR-4595 Polishing Kit: 600 grit sand paper; polishing fixture
3. HFBR-4501 Connector (gray)/Crimp Ring
4. HFBR-4511 Connector (blue)/Crimp Ring
5. Industrial Razor Blade
6. 16 gauge Latching Wire Strippers
7. Crimp Tool
   AMP 90364-1 or AMP 69876

After cutting the HFBR-3590 cable to the desired length, strip off 7 mm of the outer jacket on each end with the 16 gauge wire strippers.

*CAUTION: The plastic fiber core has a transparent cladding, which when scratched or removed would allow the light to escape through the side of the fiber. For proper termination, the cladding must not be removed or scratched. The fiber can easily be checked by passing light through the fiber — any scratches or nicks can be seen as bright spots of light on the side of the fiber, NO bright scratches or nicks are permissable.*

Place the crimp ring and connector over the end of the cable; the fiber should protrude about 3 mm through the end of the connector. Carefully position the ring so that it is entirely on the connector and then crimp the ring in place with the crimping tool. NOTE: Place the gray connector on the cable end to be connected to the transmitter and the blue connector on the cable end to be connected to the receiver to maintain the color coding.

Any excess fiber protruding from the connector end may be trimmed with the razor blade; however, the trimmed fiber should extend at least 1.5 mm from the connector end.

Insert the connector fully into the polishing fixture with the connector end protruding from the bottom of the fixture. NOTE: The four dots on the bottom of the polishing fixture are wear indicators. Replace the polishing fixture when any dot is no longer visible. Using a figure-eight motion of the polishing fixture on the 600 grit abrasive, trim the fiber and connector until the connector is flush with the end of the polishing fixture. The polishing fixture must be kept clean to accurately maintain connector tolerances.

The fiber end should be flat and smooth with no large irregularities.

## Optic Flux Measurement

The optical flux at the end of the HFBR-3500 series Fiber Optic Cable can be easily measured using a large area Radiometer such as the EG&G-550, Photodyne 88XL, or United Detector Technology S550, that has been calibrated at 665 nm.

The output flux for the HFBR-1500 Transmitter has been specified at the end of 0.5 metres of HFBR-3500 Fiber Optic Cable and can therefore be easily measured using one of the above instruments.

# Flux Budgeting

Flux budgeting calculations in fiber optic systems determine the performance of the link design. Considerations of transmitter output flux, system insertion losses and receiver input sensitivity or overload must be analyzed to determine the system performance. DC coupled receivers such as the HFBR-2500 will exhibit pulse distortion when over driven. A careful flux budget analysis can minimize the pulse distortion by driving the receiver at an optimum level.

A worst case analysis using min/max specifications will yield the guaranteed system performance over temperature, voltage variations and variations in flux coupling.

The basic flux budgeting equation for a fiber optic link is:

1. $\phi_T\,(\mathrm{dBm}) - \alpha_O\,(\mathrm{dB/m}) \cdot \ell(\mathrm{m}) = \phi_R\,(\mathrm{dBm})$

where:

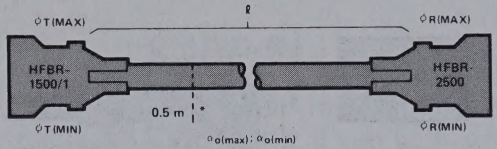
$\phi_T$ is the transmitter output flux and is a function of drive current, $I_F$ (Figure 1);

$\alpha_O$ is the cable attenuation per metre;

$\ell$ is the cable length;

$\phi_R$ is the optical flux at the receiver.

Using the basic flux budgeting equation but substituting min/max values will determine the worst case operating performance for the Snap-In Fiber Optic Link



For a system to operate under worst case conditions both equation 2 and 3 must be satisfied. Equation 2 prevents overloading the receiver and equation 3 assures that there is enough flux at the receiver for system operation.

2. $\phi_{T(max)} - \alpha_{o(min)} \cdot (\ell - 0.5)^* \leq \phi_{R(max)}$

3. $\phi_{T(min)} - \alpha_{o(max)} \cdot (\ell - 0.5)^* \geq \phi_{R(min)}$

*0.5m of cable is included in $\phi_T$.

Figure 1 gives the normalized optical flux from an HFBR Transmitter at various drive currents.

Figure 2 is a graph of equations 2 and 3 for link operation over temperature with the HFBR-2500 Receiver.

From Figure 2 a drive current can be selected for system operation at a particular cable length or the allowable cable length variation can be determined at a specific drive current for each transmitter.

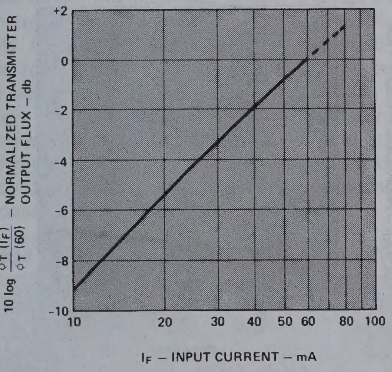


Figure 1. Normalized Transmitter Output Flux vs. Input Current

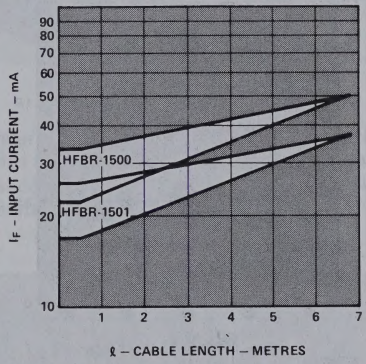


Figure 2. System Performance with HFBR-2500 Receiver and Non-Temperature Compensated Transmitters

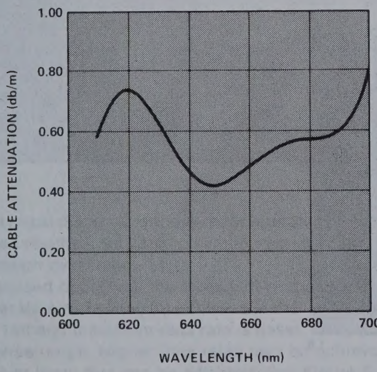


Figure 3. Cable Attenuation vs. Wavelength

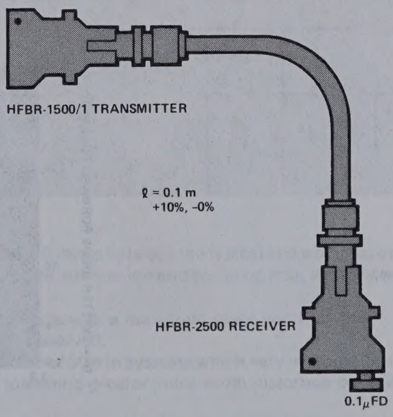


Figure 4. Circuit Layout Minimizing Length Tolerance Effects of 0.1 Metre Link

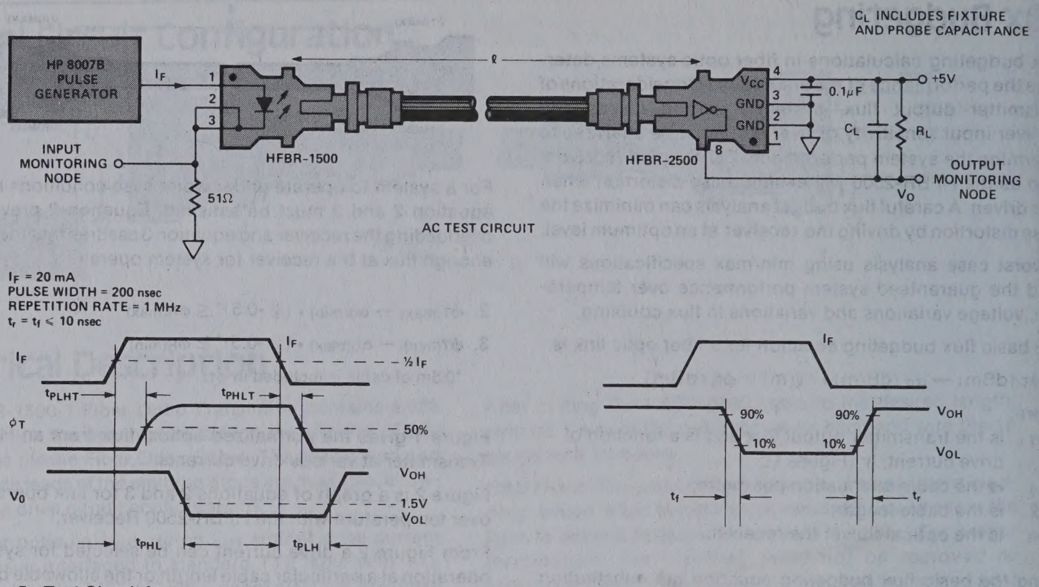

CL INCLUDES FIXTURE AND PROBE CAPACITANCE
HP 8007B PULSE GENERATOR
IF
1
2
3
ℓ
HFBR-1500
INPUT MONITORING NODE
51Ω
AC TEST CIRCUIT
VCC
GND
GND
4
3
2
1
8
0.1μF
+5V
CL
RL
HFBR-2500
OUTPUT MONITORING NODE
VO
IF = 20 mA
PULSE WIDTH = 200 nsec
REPETITION RATE = 1 MHz
tr = tf ≤ 10 nsec
IF
½ IF
tPLHT
tPHLT
ϕT
50%
VOH
V0
1.5V
VOL
tPHL
tPLH
IF
90%
90%
VOH
10%
10%
VOL
tf
tr

**Figure 5. Test Circuit for $t_{PHL}$, $t_{PLH}$, $t_f$, and $t_r$**

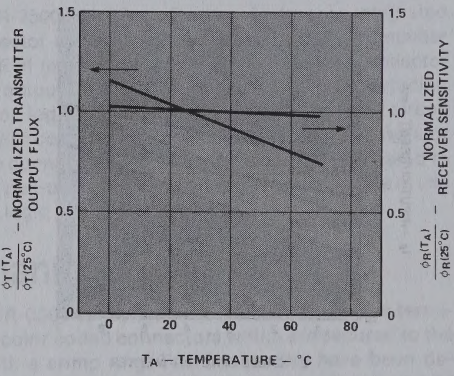


**Figure 6. Normalized Transmitter Output Flux and Receiver Sensitivity vs. Temperature**

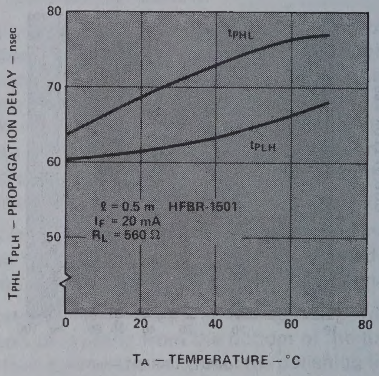


**Figure 7. $t_{PHL}$, $t_{PLH}$ vs. Temperature**

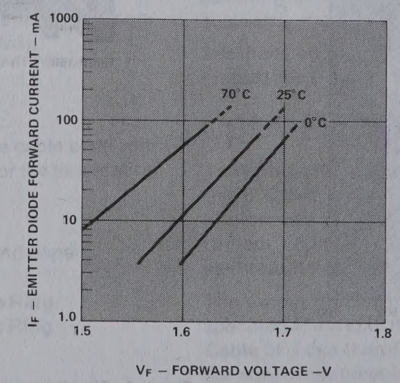


**Figure 8. Emitter Diode Forward Current vs. Forward Voltage.**

HEWLETT PACKARD

# SNAP-IN FIBER OPTIC LINK SYSTEM PERFORMANCE

## HFBR-0500 SERIES ADDENDUM

TECHNICAL DATA FEBRUARY 1982

## Features

- **EXTENDED SYSTEM PERFORMANCE TO 18 METRES**

## Description

This system performance data sheet describes Hewlett-Packard's Snap-in Fiber Optic Link, comprised of HFBR-1501 Transmitter, HFBR-2500 Receiver and HFBR-3500 series cable. The specifications given below show the conditions to extend the guaranteed system performance to distances up to 18 metres.

To achieve distances beyond 9 metres, a capacitor must be used in the transmitter drive circuit. The capacitor increases the transmitter fall time, extending the system dynamic range. For distances greater than 13 metres the transmitter must be driven in pulsed operation. Peak currents up to 160mA can be used provided that the average current does not exceed 80mA and the pulse width is less than 1ms. Maintaining the pulse width in pulsed operation may require data formatting by using a self-clocking code such as Manchester. Restricting the temperature range of operation also increases the transmission distance by reducing the guard bands necessary for worst case design.

snap-in fiber optic link
HEWLETT-PACKARD
HFBR-0500

Please refer to the SNAP-IN FIBER OPTIC LINK HFBR-0500 Series Data Sheet for additional specifications on the individual components. Please see Application Note #1009 for additional design information.

**SYSTEM PERFORMANCE** (Transmission Distance in Metres)

| | | Worst Case Maximum Distance Metres [1] | Typical Maximum Distance Metres [1] | Conditions | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $I_F$ PK Nom. (mA) | $T_A$ Range (°C) | Data Rate Baud | | Figure | Note |
| | | | | | | Min. | Max. | | |
| Without Capacitor | d.c. | 6.5 | 22 | 16 to 37 | 0 to 70 | 0 | 5M | 1,2 | |
| | | 9.0 | 24 | 13 to 45 | 0 to 55 | | | | |
| With Capacitor RC = 75ns | d.c. | 12 | 30 | 80 | 0 to 70 | 0 | 1M | 3,4 | 4 |
| | | 13 | 30 | 80 | 0 to 55 | | | | |
| | pulsed | 16 | 33 | 120 | 0 to 55 | 1K | 1M | 3,4 | 2,3,4 |
| | | 16 | 35 | 160 | 0 to 70 | | | | |
| | | 18 | 35 | 160 | 0 to 55 | | | | |

**Notes:**

1. The typical distance ranges are for operation at 25° C with $V_{CC} = 5.0V$ dc. The difference between the typical and worst case distance ranges results from variations in transmitter output flux, receiver sensitivity, cable attenuation and coupling loss, with allowance for operation over temperature.
2. For pulsed operation, the transmitter input current cannot exceed 80mA average with a maximum pulse width of 1ms.
3. Lower data rates may be achieved if the 1ms maximum input pulse width is observed.
4. The 1Mbaud maximum data rate is based on a worst case pulse width distortion of 30% in systems which vary in length over the full distance range. Higher data rates may be achieved in systems capable of tolerating greater pulse width distortion or in which the receiver input flux can be adjusted. See Figure 6.
5. See SNAP-IN FIBER OPTIC LINK HFBR-0500 Series data sheet for ac test circuit.
6. See Application Note #1009 for Flux Budget information.

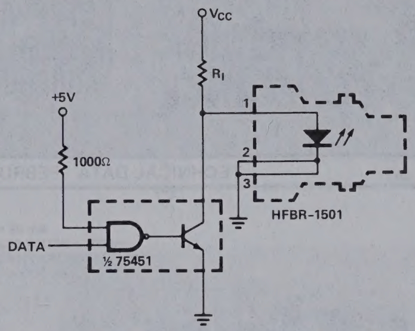

V<sub>CC</sub>
R<sub>I</sub>
+5V
1000Ω
1
2
3
HFBR-1501
DATA
½ 75451

Figure 1. Typical Circuit Configuration.

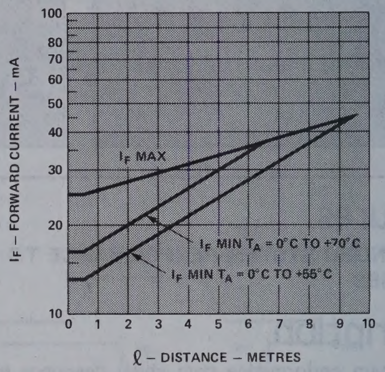


Figure 2. Worst Case System Performance Using HFBR-1501 Transmitter and HFBR-2500 Receiver.

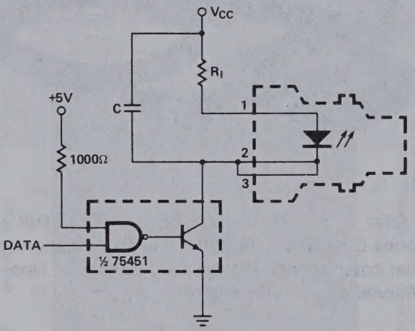

V<sub>CC</sub>
R<sub>I</sub>
+5V
C
1000Ω
1
2
3
DATA
½ 75451

Figure 3. Typical Circuit Configuration with a Capacitor.

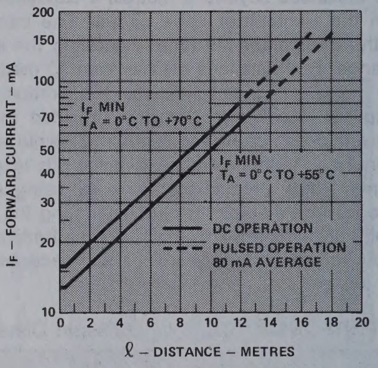


Figure 4. Worst Case System Performance Using HFBR-1501 Transmitter, HFBR-2500 Receiver and a Capacitor in the Transmitter Drive Circuit.

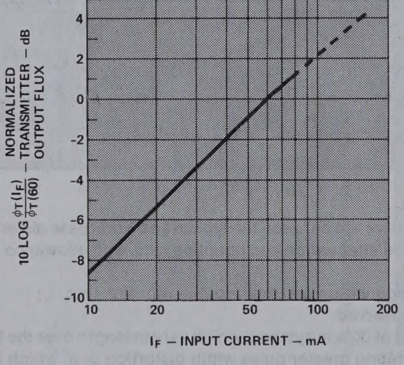


Figure 5. Normalized Transmitter Output Flux vs. Input Current. (See Note 6)

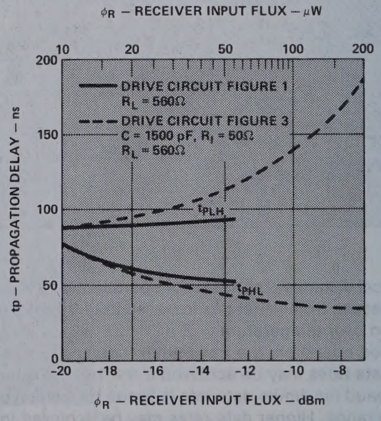


Figure 6. System Propagation Delays vs. Receiver Input Flux, $\ell = 0.5$ metres. (See Note 5)

**HEWLETT PACKARD**

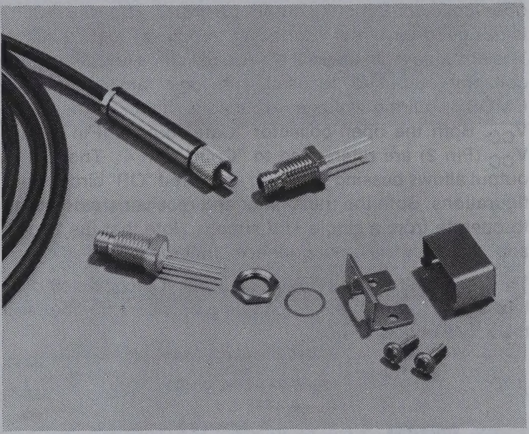
# Miniature Fiber Optic Logic Link

## HFBR-0200 SERIES

TECHNICAL DATA FEBRUARY 1982

## Features

- DC TO 5 MBAUD DATA RATE
- MAXIMUM LINK LENGTH
  500 Metres (Guaranteed)
  1200 Metres (Typical)
- TTL/CMOS COMPATIBLE OUTPUT
- MINIATURE, RUGGED METAL PACKAGE
- SINGLE +5V RECEIVER POWER SUPPLY
- INTERNALLY SHIELDED RECEIVER FOR EMI/RFI IMMUNITY
- PCB AND PANEL MOUNTABLE
- HIGH EFFICIENCY GaAlAs EMITTER



## Applications

- EMC REGULATED SYSTEMS
- EXPLOSION PROOF SYSTEMS IN OIL INDUSTRY/CHEMICAL PROCESS CONTROL INDUSTRY
- SECURE DATA COMMUNICATIONS
- WEIGHT SENSITIVE SYSTEMS (e.g. Avionics, Mobile Stations)
- HIGH VOLTAGE ISOLATION IN POWER GENERATION

## Description

The HFBR-0200 Series is a dc to 5 MBaud fiber optic data link capable of transmission over distances of 500 metres or more.

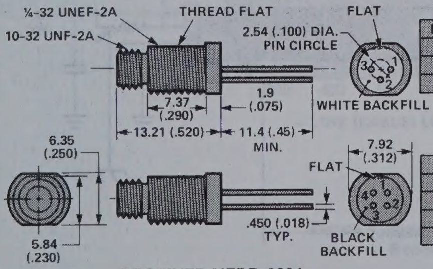
A complete evaluation kit is available (HFBR-0200) containing a transmitter, receiver, mounting hardware, 10m of cable and technical literature. The HFBR-1201 Transmitter and HFBR-2201 Receiver are housed in miniature, rugged packages compatible with the HFBR-4000 connector and HFBR-3000 series glass fiber optic cable. The HFBR-3000 series fiber optic cable can be ordered with or without installed connectors. The HFBR-0100 connector assembly kit is available if field installation of connectors is desired.

The HFBR-1201 Transmitter contains a high efficiency GaAlAs emitter operating at a wavelength of 820 nm. The transmitter is easily identified by the white epoxy backfill.

The HFBR-2201 Receiver contains an integrated photodetector and dc amplifier. An open collector Schottky transistor provides logic compatibility. The combination of an internal EMI shield, the metal package, and an isolated case ground provides excellent immunity to EMI/RFI. For unusually severe EMI/ESD environments, a metal shield is provided which snaps directly onto the mounting bracket. The receiver is easily identified by the black epoxy backfill.

## Mechanical Dimensions

**TRANSMITTER HFBR-1201**

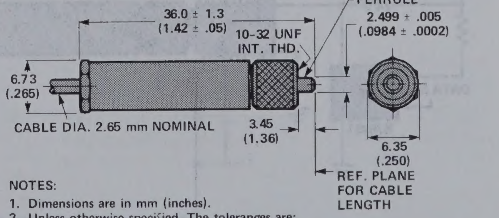

¼-32 UNEF-2A
THREAD FLAT
FLAT
10-32 UNF-2A
2.54 (.100) DIA. PIN CIRCLE
3
1
2
1.9 (.075)
WHITE BACKFILL
7.37 (.290)
13.21 (.520)
11.4 (.45) MIN.
6.35 (.250)
7.92 (.312)
FLAT
4
1
2
3
.450 (.018) TYP.
BLACK BACKFILL
5.84 (.230)

| PIN | FUNCTION |
|---|---|
| 1 | ANODE |
| 2 | CATHODE |
| 3 | CASE |

| PIN | FUNCTION |
|---|---|
| 1 | CASE |
| 2 | $V_{CC}$ |
| 3 | DATA |
| 4 | COMMON |

**RECEIVER HFBR-2201**

**HFBR-4000 CONNECTOR**


FERRULE
36.0 ± 1.3 (1.42 ± .05)
2.499 ± .005 (.0984 ± .0002)
10-32 UNF INT. THD.
6.73 (.265)
CABLE DIA. 2.65 mm NOMINAL
3.45 (1.36)
6.35 (.250)
REF. PLANE FOR CABLE LENGTH

NOTES:
1. Dimensions are in mm (inches).
2. Unless otherwise specified. The tolerances are:
   .X ± .51mm, (.XX ± .02in.)
   .XX ± .13mm, (.XXX ± .005in.)
3. Fiber end is locked flush with ferrule face.

## Electrical Description

The HFBR-1201 Transmitter contains a GaAlAs infrared emitter. Both the anode and cathode of the emitter are insulated from the case. This configuration permits the use of a variety of drive circuitry such as series switching, shunt-switching and high frequency peaking. There is no internal drive circuit or current limiter.

The HFBR-2201 Receiver incorporates an integrated photo IC containing a photodetector and dc amplifier driving an open-collector Schottky output transistor. The HFBR-2201 is designed for direct interfacing to popular logic families. The absence of an internal pull-up resistor allows the open-collector output to be used with logic families such as CMOS requiring voltage excursions much higher than $V_{CC}$. Both the open-collector "Data" output (Pin 3) and $V_{CC}$ (Pin 2) are referenced to "Com" (Pin 4). The "Data" output allows bussing, strobing and wired "OR" circuit configurations. Both the transmitter and receiver are designed to operate from a single +5V supply. Note that the "Com" and "Case" pins are not connected internally.

The HFBR-1201 and HFBR-2201 optical receptacles contain a lens to optimize the coupling between the fiber and the active optical device.

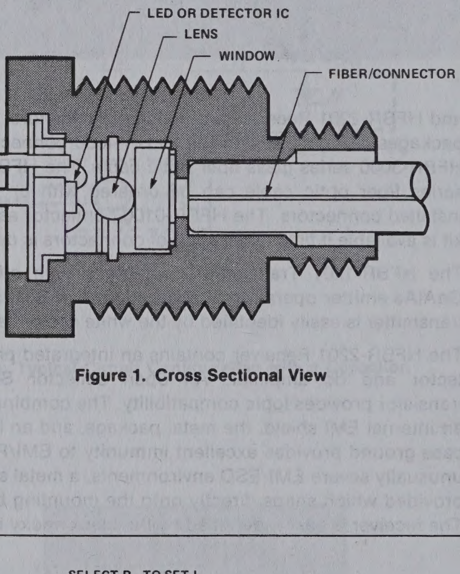


**Figure 1. Cross Sectional View**

## Mechanical Description

The HFBR-1201 fiber optic transmitter and HFBR-2201 receiver are housed in rugged metal packages intended for use with the HFBR-3000 fiber optic cable/connector assemblies. The low profile package is designed for direct mounting on printed circuit boards or through panels without additional heat sinking. A flat on the mounting threads of the device is provided to prevent rotation in all mounting configurations and to provide an orientation reference for the pin-out. Hardware is available for horizontal mounting applications on printed circuit boards. The hardware consists of a stainless steel mounting bracket fastened directly to the printed circuit board with two stainless steel self-tapping screws and a nut and washer for fastening the device in the bracket. A metal shield which snaps directly on the mounting bracket is also available for unusually severe EMI/ESD environments. When mounted in the horizontal configuration, the overall height of the component conforms with guidelines allowing printed circuit board spacing on 12.7 mm (.500) centers. A thorough environmental characterization has been performed on these products. The test data as well as information regarding operation beyond the specified limits is available from any Hewlett-Packard sales office.

## System Design Considerations

The Miniature Fiber Optic Logic Link is guaranteed to work over the entire range of 0 to 500 metres at a data rate of dc -5 MBd, with arbitrary data format and typically less than 25% pulse width distortion, if the Transmitter is driven with $I_F = 40$ mA ($R_1 = 82\Omega$). If it is desired to economize on power or achieve lower pulse distortion, then a lower drive current ($I_F$) may be used. The following example will illustrate the technique for optimizing $I_F$.

EXAMPLE: Maximum distance required = 200 meters. From Fig. 3, the worst case drive current = 20 mA. From the Transmitter data — $V_F = 1.7V$ (max.).

$$R_1 = \frac{V_{CC} - V_F}{I_F} = \frac{5 - 1.7V}{20 \text{ mA}} = 165\Omega$$

The optical power margin between the typical and worst case curves (Fig. 3) at 200 metres is 4 dB. To calculate the worst case pulse width distortion at 200 metres, see Fig. 9. The power into the Receiver is $P_{RL}$ + 4 dB = -20 dBM. Therefore, the typical distortion is 40 ns or 20% at 5 MBd.

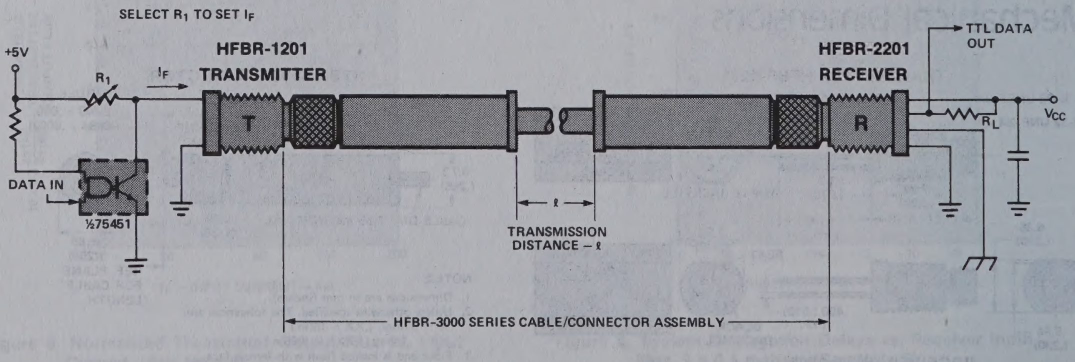

SELECT $R_1$ TO SET $I_F$
+5V
$R_1$
$I_F$
HFBR-1201
TRANSMITTER
T
DATA IN
½75451
ℓ
TRANSMISSION DISTANCE – ℓ
HFBR-3000 SERIES CABLE/CONNECTOR ASSEMBLY
HFBR-2201
RECEIVER
R
TTL DATA OUT
$R_L$
$V_{CC}$

**Figure 2.**

# Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units | Reference |
|---|---|---|---|---|---|
| **TRANSMITTER** | | | | | |
| Ambient Temperature | $T_A$ | -20 | +85 | °C | |
| Peak Forward Input Current | $I_{F, PK}$ | | 40 | mA | Note 7 |
| Average Forward Input Current | $I_{FAV}$ | | 40 | mA | Note 7 |
| **RECEIVER** | | | | | |
| Ambient Temperature | $T_A$ | -20 | +85 | °C | |
| Supply Voltage | $V_{CC}$ | 4.75 | 5.25 | V | |
| Fan Out (TTL) | N | | 5 | | Note 3, Fig. 2 |
| **CABLE** (see HFBR-3000 to 3300 data sheets) | | | | | |

# System Performance -20°C to +85°C unless otherwise specified

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Reference |
|---|---|---|---|---|---|---|---|
| Transmission Distance | ℓ | 500 | 1200 | | Metres | | Fig. 3 |
| Data Rate<br>Synchronous | | dc | | 5 | MBaud | | Note 10 |
| Asynchronous | | dc | | 2.5 | MBaud | | Note 10, Fig. 9 |
| Propagation Delay LOW to HIGH | $t_{PLH}$ | | 82 | | nsec | $T_A = 25°C$,<br>$P_R = -21$ dBm<br>$I_{F, PK} = 15$ mA<br>ℓ = 1 metre | Fig. 8, 9, 10 |
| Propagation Delay HIGH to LOW | $t_{PHL}$ | | 55 | | nsec | | |
| System Pulse Width Distortion | $t_D$ | | 27 | | nsec | | |
| Bit Error Rate | BER | | | $10^{-9}$ | | Data Rate ≤5 MBaud<br>$P_R > -24$ dBm (4μW) | |

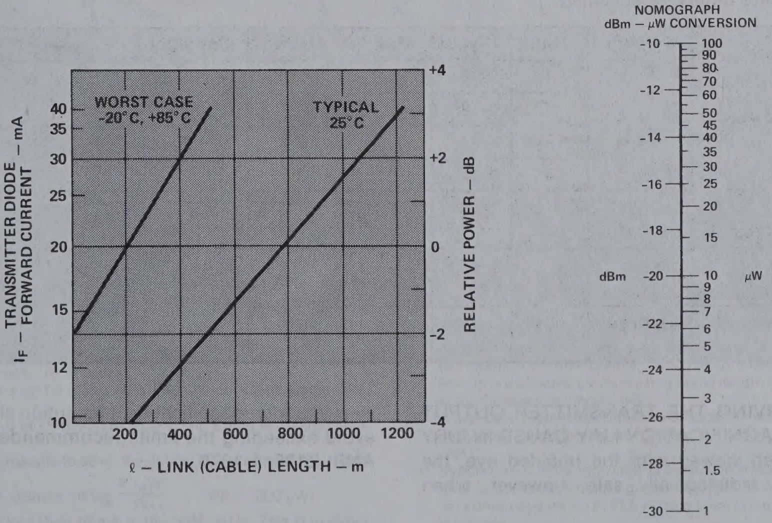


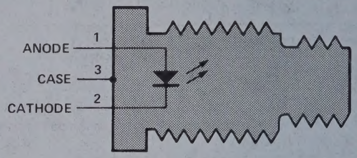
**Figure 3. System Performance: HFBR-1201/-2201 with -3000 Series Cable**

**HFBR-1201 TRANSMITTER**

## Absolute Maximum Ratings

| Parameter | | Symbol | Min. | Max. | Unit | Reference |
|---|---|---|---|---|---|---|
| Storage Temperature | | $T_S$ | -55 | +85 | °C | |
| Operating Temperature | | $T_A$ | -20 | +85 | °C | |
| Lead Soldering Cycle | Temp. | | | +260 | °C | Note 2 |
| | Time | | | 10 | sec | |
| Forward Input Current | Peak | $I_{F,PK}$ | | 40 | mA | Note 7 |
| | Average | $I_{F,AV}$ | | 40 | mA | |
| Reverse Input Voltage | | $V_{BR}$ | | 2.5 | V | |

**HFBR-1201 TRANSMITTER**



## Electrical/Optical Characteristics

-20°C to +85°C unless otherwise specified

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Reference |
|---|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | | 1.44 | 1.7 | V | $I_F = 20$ mA | Fig. 6 |
| Forward Voltage Temperature Coefficient | $\Delta V_F/\Delta T$ | | -0.91 | | mV/°C | $I_F = 20$ mA | Fig. 6 |
| Reverse Input Voltage | $V_{BR}$ | 2.5 | 4.0 | | V | $I_R = 100\ \mu A$ | |
| Numerical Aperture | NA | | .35 | | | | |
| Optical Port Diameter | $D_T$ | | 180 | | μm | | |
| Peak Emission Wavelength | $\lambda_P$ | | 820 | | nm | | Fig. 7 |

## Dynamic Characteristics

-20°C to +85°C unless otherwise specified

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Reference |
|---|---|---|---|---|---|---|---|
| Output Optical Power | $P_T$ | -20 | -19 | | dBm | $I_F = 20$ mA<br>$T_A = 25°C$ | Fig. 4<br>Note 4 |
| | | 10 | 12 | | μW | | |
| | | -21 | | | dBm | $I_F = 20$ mA<br>$-20°C < T_A < 85°C$ | |
| | | 8 | | | μW | | |
| Optical Power Temperature Coefficient | $\Delta P_T/\Delta T$ | | -.017 | | dB/°C | | Fig. 5 |
| Propagation Delay LOW to HIGH | $t_{PLHT}$ | | 17 | | nsec | $I_{F,PK} = 10$ mA | Note 8<br>Fig. 8 |
| Propagation Delay HIGH to LOW | $t_{PHLT}$ | | 6 | | nsec | | |

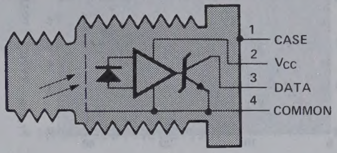
**WARNING:** OBSERVING THE TRANSMITTER OUTPUT POWER UNDER MAGNIFICATION MAY CAUSE INJURY TO THE EYE. When viewed with the unaided eye, the infrared output is radiologically safe; however, when viewed under magnification, precaution should be taken to avoid exceeding the limits recommended in ANSI Z136, 1-1976.

**HFBR-2201 RECEIVER**

# Absolute Maximum Ratings

| Parameter | | Symbol | Min. | Max. | Units | Reference |
|---|---|---|---|---|---|---|
| Storage Temperature | | $T_S$ | -55 | +85 | °C | |
| Operating Temperature | | $T_A$ | -20 | +85 | °C | |
| Lead Soldering Cycle | Temp. | | | +260 | °C | Fig. 2 |
| | Time | | | 10 | sec | |
| Supply Voltage | | $V_{CC}$ | -0.5 | +7.0 | V | |
| Output Current | | $I_O$ | | 25 | mA | |
| Output Voltage | | $V_O$ | -0.5 | +18.0 | V | |
| Output Collector Power Dissipation | | $P_{O,\ AV}$ | | 40 | mW | |

**HFBR-2201 RECEIVER**



## Electrical/Optical Characteristics -20° C to +85° C unless otherwise specified

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Reference |
|---|---|---|---|---|---|---|---|
| High Level Output Current | $I_{OH}$ | | 5 | 250 | μA | $V_O = 18V$<br>$P_R < -40$ dBm | |
| Low Level Output Voltage | $V_{OL}$ | | 0.4 | 0.5 | V | $I_O = 8$ mA<br>$P_R > -24$ dBm | |
| High Level Supply Current | $I_{CCH}$ | | 3.5 | 6.3 | mA | $V_{CC} = 5.25$ V<br>$P_R < -40$ dBm | |
| Low Level Supply Current | $I_{CCL}$ | | 6.2 | 10 | mA | $V_{CC} = 5.25$ V<br>$P_R > -24$ dBm | |
| Optical Port Diameter | $D_R$ | | 900 | | μm | | |
| Numerical Aperture | $N_A$ | | 5 | | | | |

## Dynamic Characteristics -20° C to +85° C unless otherwise specified

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions | Reference |
|---|---|---|---|---|---|---|---|
| Input Power Level Logic HIGH | $P_{RH}$ | | | -40 | dBm | $\lambda_P = 820$ nm | Note 5 |
| | | | | 0.1 | μW | | |
| Input Power Level Logic LOW | $P_{RL}$ | | -25 | | dBm | $T_A = +25°C$ | Fig. 5, Note 5 |
| | | | 3.2 | | μW | | |
| | | -24 | | | dBm | $-20 < T_A < 85°C$ | |
| | | 4.0 | | | μW | | |
| Propagation Delay LOW to HIGH | $t_{PLHR}$ | | 65 | | nsec | $T_A = 25°C$, $P_R = -21$ dBm | Note 8, Fig. 8 |
| Propagation Delay HIGH to LOW | $t_{PHLR}$ | | 49 | | nsec | | |

**Notes:**

1. Typical data at $T_A = 25°C$, $V_{CC} = 5.0V$ dc.
2. 2.0 mm from where leads enter case.
3. 8 mA load (5 x 1.6 mA). $R_L = 560\Omega$.
4. Measured at the end of 1.0 metre HFBR-3000 Fiber Optic Cable with large area detector.
5. Measured at the end of HFBR-3000 Fiber Optic Cable with large area detector.
6. When changing microwatts to dBm, the optical flux is referenced to one milliwatt (1000 μW).

$$\text{Optical Flux, } P\ (\text{dBm}) = 10 \log \frac{P\ (\mu W)}{P_O} \qquad (P_O = 1000\ \mu W)$$

7. $I_{FPK}$ should not be less than 10 mA in the "ON" state. This is to avoid the long turn-on time that occurs at low input current. $I_{FAV}$ may be arbitrarily low, as there is no duty factor restriction.
8. Propagation delay through the system is the result of several sequentially-occurring phenomena. Consequently it is a combination of data-rate-limiting effects and of transmission-time effects. Because of this, the data-rate limit of the system must be described in terms of time differentials between delays imposed on falling and rising edges.

   As the cable length is increased, the propagation delays increase at 5 ns per metre of length increase. Data rate, as limited by pulse width distortion, is not affected by increasing cable length if the optical power level at the Receiver is maintained.
9. Worst case system performance is based on worst case performance of individual components: transmitter at +85° C, receiver and cable at -20° C.
10. Synchronous data rate limit is based on these assumptions: (a) 50% duty factor modulation, e.g. Manchester I or BiPhase (Manchester II); (b) continuous data; (c) PLL (Phase Lock Loop) demodulation; (d) TTL threshold.

    Asynchronous data rate limit is based on these assumptions: (a) NRZ data; (b) arbitrary timing — no duty factor restriction; (c) TTL threshold.

    The EYE pattern describes the timing range within which there is no uncertainty of the logic state, relative to a specific threshold, due to either noise or intersymbol (prop. delay) effects.

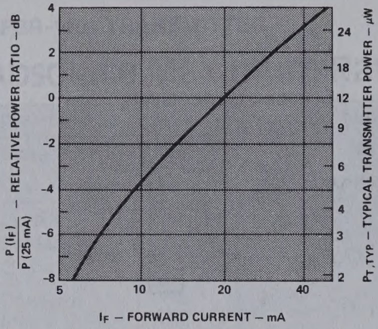


**Figure 4. Normalized Transmitter Output vs. Forward Current**

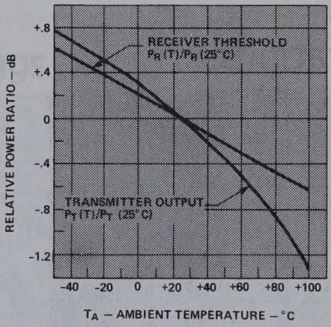


**Figure 5. Normalized Thermal Effects in Transmitter Output, Receiver Threshold, and Link Performance (Relative Threshold)**

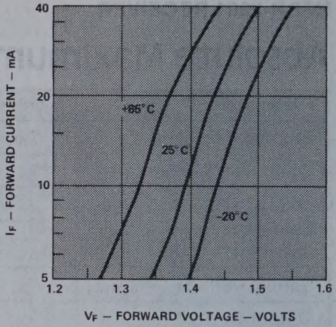


**Figure 6. Forward Voltage and Current Characteristics for the Transmitter IRED**

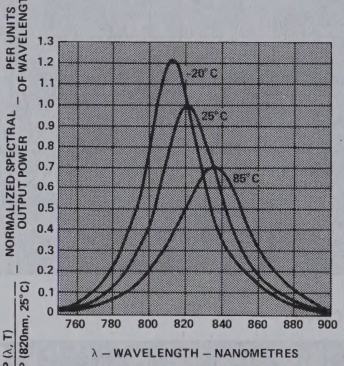


**Figure 7. Transmitter Spectrum Normalized to the Peak at 25°C**

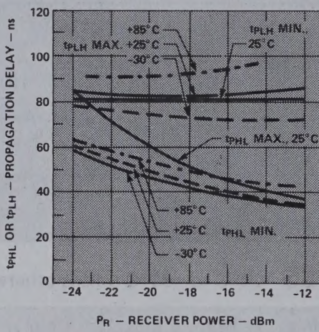


**Figure 8. Propagation Delay through System with One Metre of Cable**

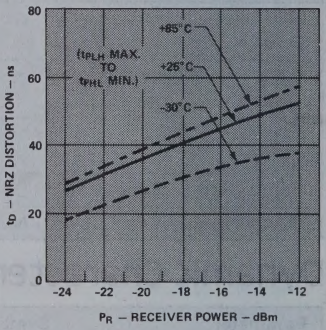


**Figure 9. Worst-Case Distortion of NRZ EYE-pattern with Pseudo Random Data at 10 Mb/s. (see note 10).**

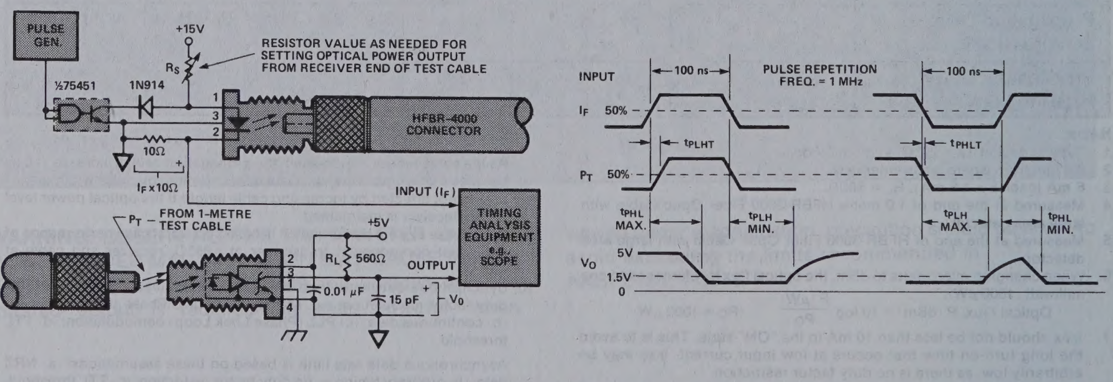
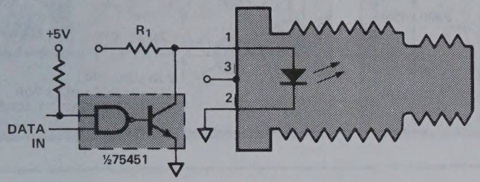
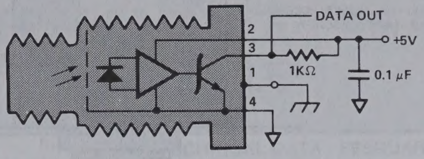

PULSE GEN.
+15V
R_S
RESISTOR VALUE AS NEEDED FOR SETTING OPTICAL POWER OUTPUT FROM RECEIVER END OF TEST CABLE
½75451
1N914
1
3
2
10Ω
I_F x10Ω
HFBR-4000 CONNECTOR
INPUT (I_F)
P_T – FROM 1-METRE TEST CABLE
+5V
R_L
560Ω
2
3
1
4
0.01 µF
15 pF
OUTPUT
V_O
TIMING ANALYSIS EQUIPMENT e.g. SCOPE
INPUT
100 ns
PULSE REPETITION FREQ. = 1 MHz
100 ns
I_F
50%
t_PLHT
t_PHLT
P_T
50%
t_PHL MAX.
t_PLH MIN.
t_PLH MAX.
t_PHL MIN.
V_O
5V
1.5V
0

**Figure 10. System Propagation Delay Test Circuit and Waveform Timing Definitions**

## Typical Circuit Configuration


+5V
R1
1
3
2
DATA IN
½75451

**HFBR-1201 TRANSMITTER**


DATA OUT
+5V
2
3
1
4
1KΩ
0.1 μF

**HFBR-2201 RECEIVER**

Good system performance requires clean port optics and cable ferrules to avoid obstructing the optical path. Clean compressed air often is sufficient to remove particles of dirt; methanol or Freon™ on a cotton swab also works well.

It is essential that a bypass capacitor (0.01 μF to 0.1 μF ceramic) be connected from pin 2 to pin 4 of the receiver. Total lead length between both ends of the capacitor and the pins should not exceed 20 mm.

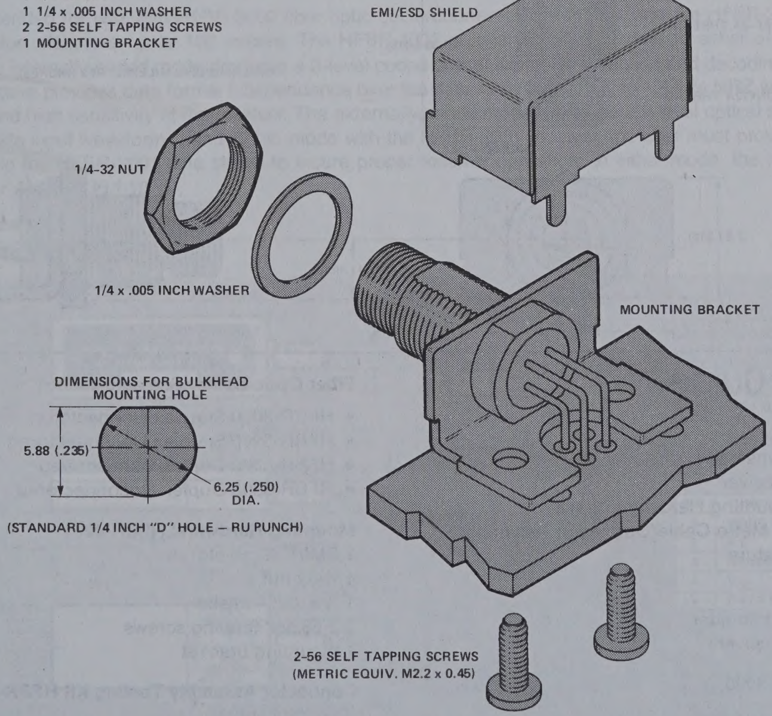
## Horizontal PCB Mounting

Mounting at the edge of a printed circuit board with the lock nut overhanging the edge is recommended.

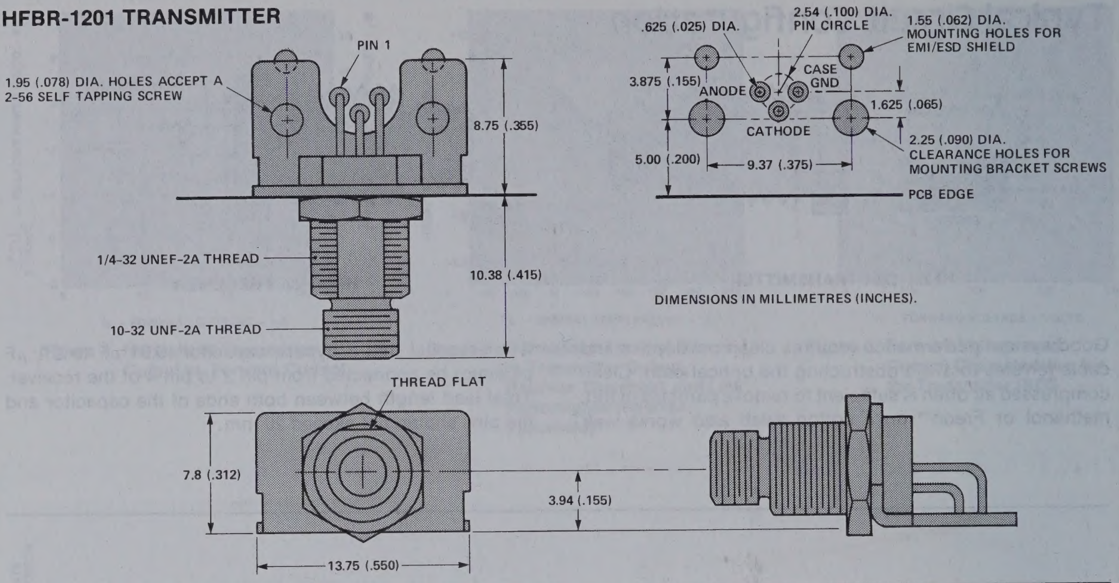
When bending the leads, avoid sharp bends right where the lead enters the backfill. Use needle nose pliers to support the leads at the base of the package and bend the leads as desired.

When soldering, it is advisable to leave the protective cap on the unit to keep the optics clean.

MOUNTING HARDWARE: HFBR-4201
- 1 EMI/ESD SHIELD
- 1 1/4-32 NUT
- 1 1/4 x .005 INCH WASHER
- 2 2-56 SELF TAPPING SCREWS
- 1 MOUNTING BRACKET

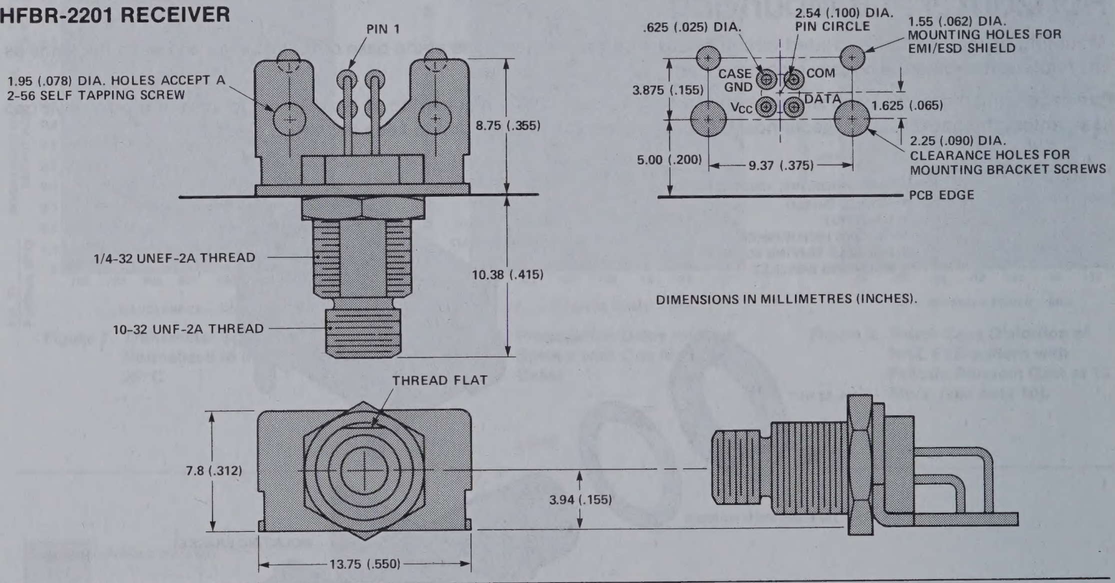

EMI/ESD SHIELD
1/4-32 NUT
1/4 x .005 INCH WASHER
MOUNTING BRACKET
DIMENSIONS FOR BULKHEAD MOUNTING HOLE
5.88 (.235)
6.25 (.250) DIA.
(STANDARD 1/4 INCH "D" HOLE – RU PUNCH)
2-56 SELF TAPPING SCREWS (METRIC EQUIV. M2.2 x 0.45)

## HFBR-1201 TRANSMITTER


PIN 1
1.95 (.078) DIA. HOLES ACCEPT A 2-56 SELF TAPPING SCREW
8.75 (.355)
1/4-32 UNEF-2A THREAD
10.38 (.415)
10-32 UNF-2A THREAD
THREAD FLAT
7.8 (.312)
3.94 (.155)
13.75 (.550)
.625 (.025) DIA.
2.54 (.100) DIA. PIN CIRCLE
1.55 (.062) DIA. MOUNTING HOLES FOR EMI/ESD SHIELD
3.875 (.155)
ANODE
CASE GND
CATHODE
1.625 (.065)
2.25 (.090) DIA. CLEARANCE HOLES FOR MOUNTING BRACKET SCREWS
5.00 (.200)
9.37 (.375)
PCB EDGE

DIMENSIONS IN MILLIMETRES (INCHES).

## HFBR-2201 RECEIVER


PIN 1
1.95 (.078) DIA. HOLES ACCEPT A 2-56 SELF TAPPING SCREW
8.75 (.355)
1/4-32 UNEF-2A THREAD
10.38 (.415)
10-32 UNF-2A THREAD
THREAD FLAT
7.8 (.312)
3.94 (.155)
13.75 (.550)
.625 (.025) DIA.
2.54 (.100) DIA. PIN CIRCLE
1.55 (.062) DIA. MOUNTING HOLES FOR EMI/ESD SHIELD
3.875 (.155)
CASE GND
COM
Vcc
DATA
1.625 (.065)
2.25 (.090) DIA. CLEARANCE HOLES FOR MOUNTING BRACKET SCREWS
5.00 (.200)
9.37 (.375)
PCB EDGE

DIMENSIONS IN MILLIMETRES (INCHES).

# Ordering Guide

**HFBR-0200 Kit:**

- HFBR-1201 Transmitter
- HFBR-2201 Receiver
- HFBR-4201 Mounting Hardware (2 sets)
- HFBR-3000 10 Metre Cable/Connector Assembly
- Technical Literature

**Modules:**
HFBR-1201 — Transmitter
HFBR-2201 — Receiver

**Connector HFBR-4000**
(See data sheet)

**Fiber Optic Cable** (See data sheet)

- HFBR-3000 Simplex Connectored
- HFBR-3200 Simplex Unconnectored
- HFBR-3100 Duplex Connectored
- HFBR-3300 Duplex Unconnectored

**Mounting Hardware:** HFBR-4201
1 EMI/ESD shield
1 ¼-32 nut
1 ¼ x .005" washer
2 2-56 self tapping screws
1 mounting bracket

**Connector Assembly Tooling Kit HFBR-0100**
(See data sheet)

**HEWLETT PACKARD**

# FIBER OPTIC 100m HIGH PERFORMANCE TRANSMITTER MODULE

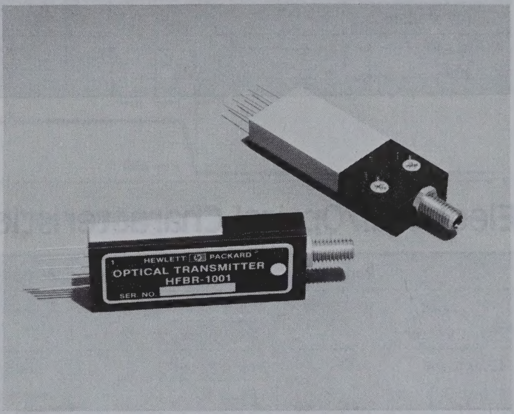
## HFBR-1001

TECHNICAL DATA FEBRUARY 1982

## Features

- **TRANSMISSION LENGTH: 100 METRES***
- **DATA RATE: DC TO 10 Mbaud***
- **NO DATA ENCODING REQUIRED***
- **TTL INPUT LEVELS**
- **FUNCTIONAL LINK MONITORING***
- **SINGLE +5V SUPPLY**
- **PCB MOUNTABLE, LOW PROFILE**
- **INTEGRAL, HIGH QUALITY OPTICAL CONNECTOR**

*When used with HFBR-2001 Receiver and any Hewlett Packard HFBR-3000/-3100 Series Cable/Connector Assembly.

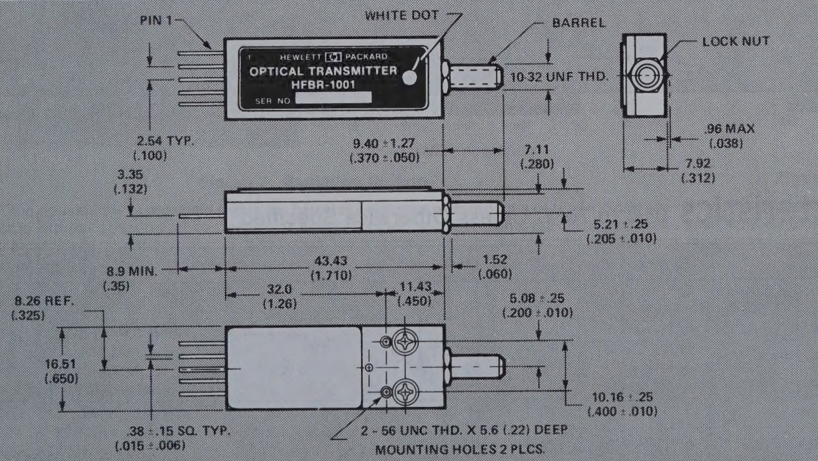

HEWLETT PACKARD
OPTICAL TRANSMITTER
HFBR-1001
SER. NO.

## Description

The HFBR-1001 fiber optic transmitter is an integrated electrical to optical transducer designed for digital data transmission over single fiber channels. A bipolar integrated circuit and a GaAsP LED convert TTL level inputs to optical pulses at data rates from dc to 10Mb/s NRZ. An integral optical connector on the module allows easy interfacing without problems of source/fiber alignment. The low profile package is designed for direct printed circuit board mounting without additional heat sinking.

The HFBR-1001 is intended for use with HFBR-3000 fiber optic cable/connector assemblies, and the HFBR-2001 fiber optic receiver for transmission distances up to 100 metres. The HFBR-1001 generates optical signals in either of two externally selectable modes. The internally-coded mode produces a 3-level coded optical signal for reception and decoding by the HFBR-2001 receiver. This feature provides data format independence over the data rate range of dc to 10Mb/s NRZ while allowing for wide dynamic range and high sensitivity at the receiver. The externally-coded mode produces a 2-level optical signal which is a digital replica of the data input waveform. Used in this mode with the HFBR-2001 receiver, the user must provide proper data formatting (explained in the HFBR-2001 data sheet) to insure proper receiver operation. In either mode, the radiant output is radiologically safe (per ANSI Z136.1-1976).

## Package Dimensions


PIN 1
WHITE DOT
BARREL
LOCK NUT
HEWLETT PACKARD
OPTICAL TRANSMITTER
HFBR-1001
SER. NO.
10-32 UNF THD.
2.54 TYP. (.100)
9.40 ± 1.27 (.370 ± .050)
7.11 (.280)
.96 MAX (.038)
7.92 (.312)
3.35 (.132)
5.21 ± .25 (.205 ± .010)
8.9 MIN. (.35)
43.43 (1.710)
1.52 (.060)
32.0 (1.26)
11.43 (.450)
8.26 REF. (.325)
5.08 ± .25 (.200 ± .010)
16.51 (.650)
10.16 ± .25 (.400 ± .010)
.38 ± .15 SQ. TYP. (.015 ± .006)
2 - 56 UNC THD. X 5.6 (.22) DEEP MOUNTING HOLES 2 PLCS.

CAUTION:

1. LOCK NUT AND BARREL SHOULD NOT BE DISTURBED.
2. SCREWS ENTERING THE 2-56 THREADED MOUNTING HOLES MUST NOT TOUCH BOTTOM.
3. THE HFBR-3000 CONNECTOR SHOULD NOT BE TIGHTENED BEYOND THE LIMITS SPECIFIED IN THE HFBR-3000 DATA SHEET.

| PIN | FUNCTION |
|---|---|
| 1 | MODE SELECT |
| 2 | N.C. |
| 3 | GROUND |
| 4 | $V_{CC}$ |
| 5 | DATA INPUT |

NOTES:

1. DIMENSIONS IN mm (INCHES)
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ±.38mm (±.015")

## Absolute Maximum Ratings

| Parameter | | Symbol | Min | Max | Units | Note |
|---|---|---|---|---|---|---|
| Storage Temperature | | $T_S$ | -55 | +85 | °C | |
| Operating Temperature | | $T_A$ | 0 | 70 | °C | |
| Lead Soldering | Temperature | | | 260 | °C | 3 |
| | Time | | | 10 | s | |
| Supply Voltage | | $V_{CC}$ | -0.5 | 6 | V | |
| Mode Select or Data Input Voltage | | $V_I$ | -0.5 | 5.5 | V | |

## Recommended Operating Conditions

| Parameter | Symbol | Min | Max | Units | Note |
|---|---|---|---|---|---|
| Ambient Temperature | $T_A$ | 0 | 70 | °C | |
| Supply Voltage | $V_{CC}$ | 4.75 | 5.25 | V | 4 |
| High Level Input Voltage, Mode Select or Data Input | $V_{IH}$ | 2.0 | $V_{CC}$ | V | |
| Low Level Input Voltage, Mode Select or Data Input | $V_{IL}$ | 0 | 0.8 | V | |
| Data Input Voltage Pulse Duration (high or low) | $t_H$, $t_L$ | 100 | | ns | |

## Electrical/Optical Characteristics 0° C to 70° C Unless Otherwise Specified

| Parameter | | Symbol | Min | Typ[6] | Max | Units | Conditions | | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| High Level Input Current | Mode Select | $I_{IH}$ | | | 100 | μA | $V_{CC}$ = 5.25V, $V_I$ = 2.4V | | 2 | |
| | Data Input | | | | 20 | | | | | |
| Low Level Input Current | Mode Select | $I_{IL}$ | | | -1.6 | mA | $V_{CC}$ = 5.25V, $V_I$ = 0.4V | | | |
| | Data Input | | | | -0.6 | | | | | |
| Supply Current | Externally-Coded Mode | $I_{CC}$ | | | 170 | mA | Mode Select High | Data Input High $V_{CC}$ = 5.25V | 1, 2 | 5 |
| | | | 40 | | | | | Data Input Low $V_{CC}$ = 4.75V | | |
| | Internally-Coded Mode | | 68 | 95 | 125 | | Mode Select Low | Data Input High or Low $V_{CC}$ = 5.25V | | |
| Optical Flux | High Level | $\phi_H$ | | 67 | | μW | Mode Select High | Data Input High | 1, 2, 3 | |
| | Low Level | $\phi_L$ | | 3 | | | | Data Input Low | | |
| | Mid Level (average) | $\phi_M$ | | 35 | | | Mode Select Low | Data Input Square Wave at 500 kHz | | |
| | Excursion $\left(\frac{\text{peak-to-peak}}{2}\right)$ | $\Delta\phi$ | 22 | 32 | | | Mode Select High | | | 9 |
| Amplitude Symmetry, Flux Excursion Ratio | | k | 0.8 | | 1.2 | — | Mode Select Low | | 1 | 7 |
| Exit Numerical Aperture | | N.A. | | 0.5 | | — | | | 3 | |
| Optical Port (fiber optic core) Diam. | | $D_C$ | | 200 | | μm | | | | |
| Coupling Loss | from area mismatch | $\alpha_A$ | | 6.0 | | dB | with HFBR-3000 Cable/Connector Assembly | | | |
| | from numerical aperture mismatch | $\alpha_{N.A.}$ | | 4.0 | | | | | | |
| Peak Emission Wavelength | | $\lambda_P$ | | 700 | | nm | | | 4 | |

## Dynamic Characteristics 0° C to 70° C Unless Otherwise Specified

| Parameter | | Symbol | Min | Typ[6] | Max | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay | High-to-Low Data Input Voltage Step | $t_{PHL}$ | | 31 | | ns | $V_{CC}$ = 4.75 V | 1 | 8 |
| | Low-to-High Data Input Voltage Step | $t_{PLH}$ | | 35 | | ns | | | |
| Refresh Pulse Internally-Coded Mode | Duration | $t_p$ | | 60 | | ns | $V_{CC}$ = 5.00 V, Mode Select Low | 1 | 8 |
| | Repetition Rate | $f_R$ | | 400 | | kHz | | | |

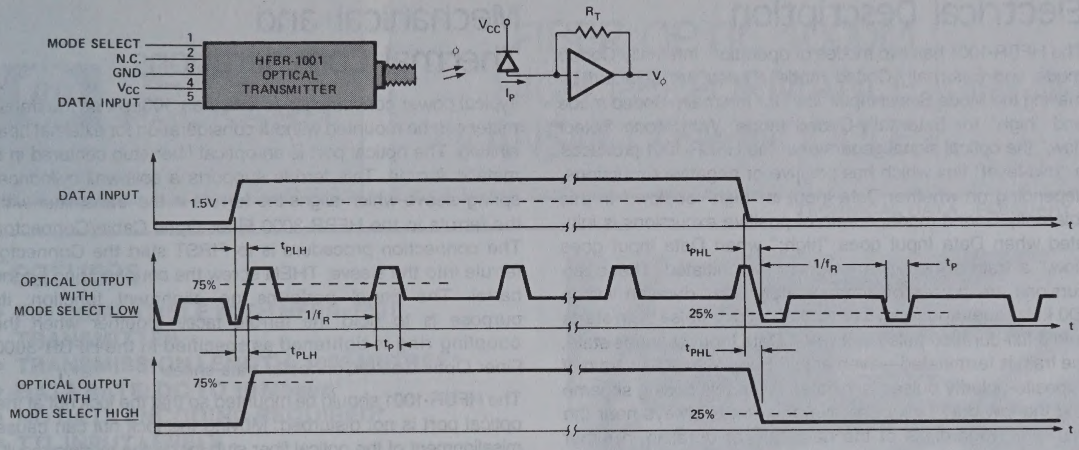

MODE SELECT
N.C.
GND
$V_{CC}$
DATA INPUT
1
2
3
4
5
HFBR-1001
OPTICAL
TRANSMITTER
$\phi$
$V_{CC}$
$I_P$
$R_T$
$V_\phi$
DATA INPUT
1.5V
$t_{PLH}$
$t_{PHL}$
OPTICAL OUTPUT WITH MODE SELECT LOW
75%
25%
$1/f_R$
$t_P$
$t_{PLH}$
$t_{PHL}$
OPTICAL OUTPUT WITH MODE SELECT HIGH
75%
25%
t

**Figure 1. Flux Coding and Timing Diagram.**

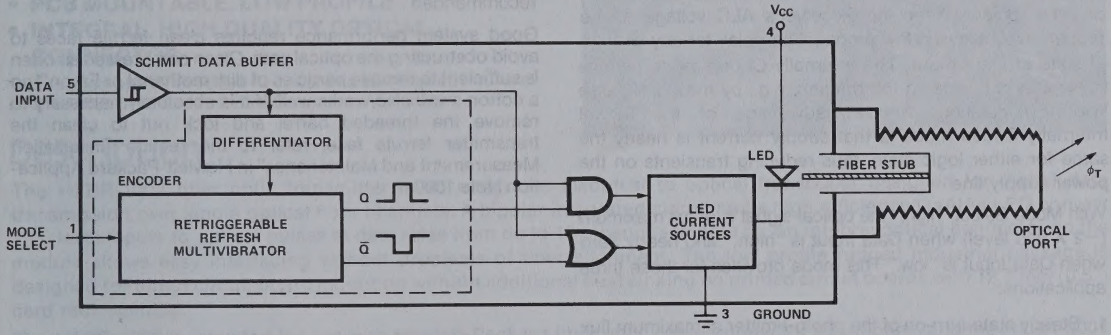

SCHMITT DATA BUFFER
DATA INPUT
5
DIFFERENTIATOR
ENCODER
MODE SELECT
1
RETRIGGERABLE REFRESH MULTIVIBRATOR
Q
$\bar{Q}$
$V_{CC}$
4
LED
LED CURRENT SOURCES
FIBER STUB
$\phi_T$
OPTICAL PORT
3
GROUND

**Figure 2. Schematic Diagram.**

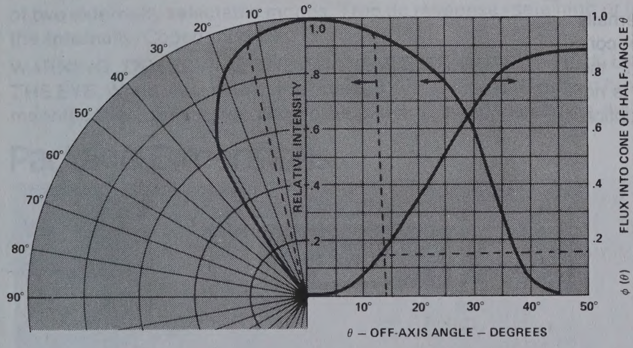


**Figure 3. Radiation Pattern.***

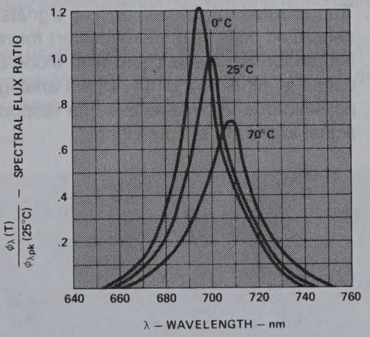


**Figure 4. Emission Spectrum.**

*The optical fiber is recessed within the barrel at a distance of approximately 7mm. Solid line represents radiation pattern from fiber stub without obscuration by connector barrel. Dashed line represents radiation pattern as seen from outside of connector.

Notes (cont'd):

3. Measured at a point 2mm (.079 in.) from where lead enters package.
4. A supply decoupling network of 2.2$\mu$H with 60$\mu$F is recommended.
5. Average currents for steady-state conditions at Data Input.
6. For typical values, $V_{CC} = 5.00V$ and $T_A = 25°C$.
7. Flux excursion ratio, k, is the ratio of flux excursion above mid level to flux excursion below mid level. $k = \frac{\phi_H - \phi_M}{\phi_M - \phi_L}$
8. The refresh pulse is interrupted (abbreviated) if Data Input changes state during the refresh pulse. MAX propagation delay is for Data Input changing state during the maximum excursion of the refresh pulse.
9. Flux excursion $\Delta\phi = 0.5\,(\phi_H - \phi_L)$, or $\Delta\phi = 0.5\,(\phi_M - \phi_L) \bullet (1+k)$.

Notice that under the conditions specified for $\Delta\phi$, the **average** flux is $(\Delta\phi + \phi_L)$.

# Electrical Description

The HFBR-1001 has two modes of operation: Internally-Coded mode and Externally-Coded mode. These are selected by making the Mode Select input "low" for Internally-Coded mode and "high" for Externally-Coded mode. With Mode Select "low," the optical signal generator in the HFBR-1001 produces a "mid-level" flux which has positive or negative excursions, depending on whether Data Input is "high" or "low." In this Internally-Coded mode, a train of positive excursions is initiated when Data Input goes "high;" when Data Input goes "low," a train of negative excursions is initiated. These excursions are pulses of approximately 60ns duration with a 400 kHz repetition rate. Each initiation of a pulse train starts with a full-duration pulse, but when Data Input changes state, the train is terminated—even at mid-pulse—as a new train of opposite-polarity pulses is initiated. With this coding scheme and the low duty factor, the average flux is always near the mid-level, regardless of the data rate or duration in either state. This coding scheme is designed to operate the HFBR-2001 Fiber Optic Receiver most effectively; the mid-level flux operates the Receiver's dc-restorer and the "refresh" pulses of either polarity keep the Receiver's ALC voltage at the proper level, allowing low propagation delay for any change of state at Data Input. The Internally-Coded mode permits transmission of analog information, e.g., by means of Pulse Width Modulation. Another advantage of the 3-level Internally-Coded mode is that supply current is nearly the same for either logic state, thus reducing transients on the power supply line.

With Mode Select "high," the optical signal is at full maximum (~2 X mid level) when Data Input is "high," and nearly zero when Data Input is "low." This mode provides for these three applications:

1. Steady state turn-on of the photo-emitter at maximum flux level (e.g., for system diagnosis).
2. Stand-by mode (e.g., when the system is not in use).
3. Transmission of 2-level optical signals from externally generated code (e.g., Manchester) for receivers not configured for the 3-level code. With Mode Select "high," the output is either $\phi_H$, or $\phi_L$. Direct analog operation is not possible due to hysteresis in the response of the optical signal to the Data Input signal.

# Mechanical and Thermal Considerations

Typical power consumption is less than 500mW so the transmitter can be mounted without consideration for external heat sinking. The optical port is an optical fiber stub centered in a metallic ferrule. This ferrule supports a split-wall cylindrical spring sleeve which aligns the ferrule in the Transmitter with the ferrule in the HFBR-3000 Fiber Optic Cable/Connector. The connection procedure is to FIRST start the Connector ferrule into the sleeve; THEN screw the coupling ring on the barrel. The barrel performs no alignment function; its purpose is to hold the ferrule faces together when the coupling ring is tightened as specified in the HFBR-3000 Fiber Optic Cable/Connector data sheet.

The HFBR-1001 should be mounted so that the lock nut at the optical port is not disturbed. Moving the lock nut can cause misalignment of the optical fiber stub inside the module resulting in a reduction of power output. Mounting at the edge of a printed circuit board with the lock nut overhanging the edge is recommended.

Good system performance requires clean ferrule faces to avoid obstructing the optical path. Clean compressed air often is sufficient to remove particles of dirt; methanol or Freon™ on a cotton swab also works well. If it is absolutely necessary to remove the threaded barrel and lock nut to clean the transmitter ferrule face, refer to the section "Installation Measurement and Maintenance" in Hewlett-Packard Application Note 1000.

**HEWLETT PACKARD**

# FIBER OPTIC 1000M HIGH PERFORMANCE TRANSMITTER MODULE

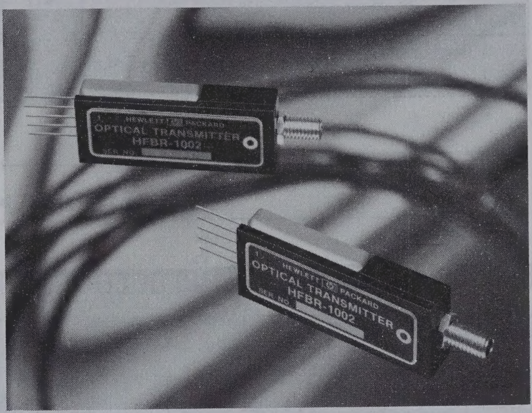
## HFBR-1002

TECHNICAL DATA FEBRUARY 1982

## Features

- PIN COMPATIBLE WITH HFBR-1001 TRANSMITTER
- TRANSMISSION LENGTH: 1000 METRES*
- DATA RATE: DC TO 10 Mbaud*
- NO DATA ENCODING REQUIRED*
- TTL INPUT LEVELS
- FUNCTIONAL LINK MONITORING*
- SINGLE +5V SUPPLY
- PCB MOUNTABLE, LOW PROFILE
- INTEGRAL, HIGH QUALITY OPTICAL CONNECTOR

*When used with HFBR-2001 Receiver and any Hewlett Packard HFBR-3000/-3100 Series Cable/Connector Assembly.


HEWLETT PACKARD
OPTICAL TRANSMITTER
HFBR-1002
SER. NO.

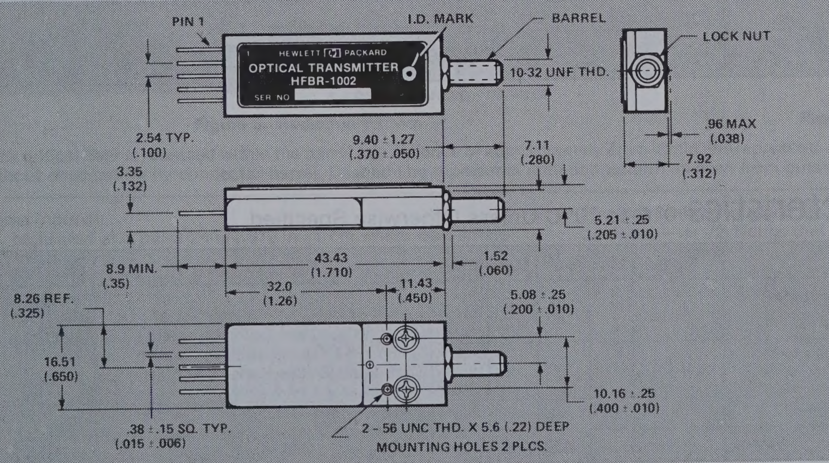
## Description

The HFBR-1002 fiber optic transmitter is an integrated electrical to optical transducer designed for digital data transmission over single optical fiber channels. A bipolar integrated circuit and a high efficiency GaAlAs LED convert TTL level inputs to optical pulses at data rates from dc to 10 Mbaud (see note 5). An integral optical connector on the module allows easy interfacing without problems of fiber alignment. The low profile rugged industrial package is designed for direct circuit board mounting without additional heat sinking on printed circuit boards with 12.7 mm (0.5") card rack spacing.

The HFBR-1002 is intended for use with Hewlett-Packard fiber optic cable/connector assemblies, and the HFBR-2001 fiber optic receiver for transmission distances to 1000 metres. It is a direct replacement for extending links currently using the HFBR-1001 (100 metre) transmitter to give 1000 metre capability. The HFBR-1002 generates optical signals in either of two externally selectable modes. True dc response (data high or low for arbitrary time interval) is available when using the Internally-Coded mode.

WARNING: OBSERVING THE TRANSMITTER OUTPUT FLUX UNDER MAGNIFICATION MAY CAUSE INJURY TO THE EYE. When viewed with the unaided eye, the near IR output flux is radiologically safe; however, when viewed under magnification, precaution should be taken to avoid exceeding the limits recommended in ANSI Z136.1-1976.

## Package Dimensions


PIN 1
I.D. MARK
BARREL
LOCK NUT
HEWLETT PACKARD
OPTICAL TRANSMITTER
HFBR-1002
SER NO
10-32 UNF THD.
2.54 TYP. (.100)
9.40 ± 1.27 (.370 ± .050)
7.11 (.280)
.96 MAX (.038)
7.92 (.312)
3.35 (.132)
5.21 ± .25 (.205 ± .010)
8.9 MIN. (.35)
43.43 (1.710)
1.52 (.060)
32.0 (1.26)
11.43 (.450)
5.08 ± .25 (.200 ± .010)
8.26 REF. (.325)
16.51 (.650)
10.16 ± .25 (.400 ± .010)
.38 ± .15 SQ. TYP. (.015 ± .006)
2 – 56 UNC THD. X 5.6 (.22) DEEP MOUNTING HOLES 2 PLCS.

CAUTION:

1. LOCK NUT AND BARREL SHOULD NOT BE DISTURBED.
2. SCREWS ENTERING THE 2-56 THREADED MOUNTING HOLES MUST NOT TOUCH BOTTOM.
3. THE CONNECTOR SHOULD NOT BE TIGHTENED BEYOND THE LIMITS SPECIFIED IN THE HEWLETT-PACKARD CABLE/ CONNECTOR DATA SHEET (FINGER TIGHT).

| PIN | FUNCTION |
|---|---|
| 1 | MODE SELECT |
| 2 | N.C. |
| 3 | GROUND |
| 4 | $V_{CC}$ |
| 5 | DATA INPUT |

NOTES:

1. DIMENSIONS IN mm (INCHES)
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ± .38mm (± .015")

# Absolute Maximum Ratings

| Parameter | | Symbol | Min | Max | Units | Note |
|---|---|---|---|---|---|---|
| Storage Temperature | | $T_S$ | -55 | +85 | °C | |
| Operating Temperature | | $T_A$ | 0 | +70 | °C | |
| Lead Soldering | Temperature | | | 260 | °C | 3 |
| | Time | | | 10 | s | |
| Supply Voltage | | $V_{CC}$ | -0.5 | 6 | V | |
| Mode Select or Data Input Voltage | | $V_I$ | -0.5 | 5.5 | V | |

# Recommended Operating Conditions

| Parameter | Symbol | Min | Max | Units | Note |
|---|---|---|---|---|---|
| Ambient Temperature | $T_A$ | 0 | +70 | °C | |
| Supply Voltage | $V_{CC}$ | 4.75 | 5.25 | V | 4 |
| High Level Input Voltage, Mode Select or Data Input | $V_{IH}$ | 2.0 | $V_{CC}$ | V | |
| Low Level Input Voltage, Mode Select or Data Input | $V_{IL}$ | 0 | 0.8 | V | |
| Data Input Voltage Pulse Duration (high or low) | $t_H, t_L$ | 100 | | ns | 5 |
| Transmission Distance | $\ell$ | | 1000 | m | 6 |

# Electrical/Optical Characteristics 0°C to +70°C Unless Otherwise Specified

| Parameter | | Symbol | Min | Typ[7] | Max | Units | Conditions | | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| Optical Flux | Transmitter Output $\left(\frac{\text{peak-to-peak}}{2}\right)$ | $\phi_T$ | -13 | -11 | | dBm | Mode Select High | Data Input Square Wave at 500 kHz | 1, 2, 3, 5 | 8 |
| | | | 50 | 80 | | μW | | | | |
| | High Level | $\phi_H$ | | 165 | | μW | Mode Select High | Data Input High | | |
| | Low Level | $\phi_L$ | | 5 | | | | Data Input Low | | |
| | Mid Level | $\phi_M$ | | 85 | | | Mode Select Low | Data Input Square Wave at 500 kHz | | |
| Amplitude Symmetry, Flux Excursion Ratio | | k | 0.8 | | 1.2 | — | Mode Select Low | | 1 | 9 |
| Exit Numerical Aperture | | N.A. | | 0.3 | | — | | | 3 | |
| Optical Port (fiber optic core) Diam. | | $D_C$ | | 100 | | μm | | | | |
| Coupling Loss | Transmitter Optical Port to Cable/Connector Assy. | $\alpha_{T\text{-}C}$ | | 3.0 | | dB | With Hewlett-Packard Cable/ Connector Assembly | | | |
| Peak Emission Wavelength | | $\lambda_{PK}$ | | 820 | | nm | | | 4 | |
| High Level Input Current | Mode Select | $I_{IH}$ | | | 100 | μA | $V_{CC} = 5.25V, V_I = 2.4V$ | | 2 | |
| | Data Input | | | | 20 | | | | | |
| Low Level Input Current | Mode Select | $I_{IL}$ | | | -1.6 | mA | $V_{CC} = 5.25V, V_I = 0.4V$ | | | |
| | Data Input | | | | -0.6 | | | | | |
| Supply Current | Externally-Coded Mode | $I_{CC}$ | | | 170 | mA | Mode Select High | Data Input High $V_{CC} = 5.25V$ | 1, 2 | 10 |
| | | | 40 | | | | | Data Input Low $V_{CC} = 4.75V$ | | |
| | Internally-Coded Mode | | 68 | 95 | 125 | | Mode Select Low | Data Input High or Low, $V_{CC} = 5.25V$ | | |

# Dynamic Characteristics 0°C to 70°C Unless Otherwise Specified

| Parameter | | Symbol | Min | Typ[7] | Max | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay | High-to-Low Data Input Voltage Step | $t_{PHL}$ | | 34 | | ns | $V_{CC} = 4.75$ V<br>Data Input Square Wave at 500 kHz | 1 | 11 |
| | Low-to-High Data Input Voltage Step | $t_{PLH}$ | | 32 | | ns | | | |
| Refresh Pulse Internally-Coded Mode | Duration | $t_p$ | | 40 | | ns | $V_{CC} = 5.00$ V, Mode Select Low | 1 | 11 |
| | Repetition Rate | $f_R$ | | 400 | | kHz | | | |

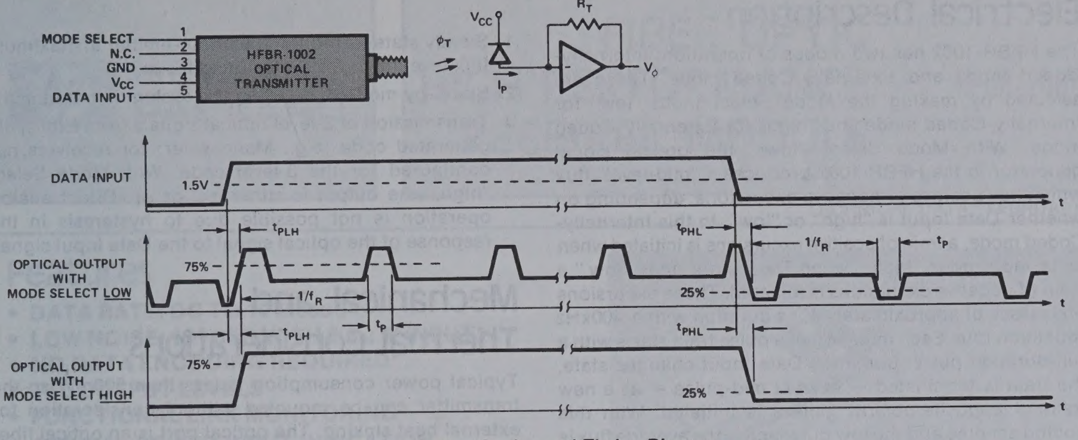

MODE SELECT
N.C.
GND
$V_{CC}$
DATA INPUT
1
2
3
4
5
HFBR-1002 OPTICAL TRANSMITTER
$\phi_T$
$V_{CC}$
$R_T$
$I_P$
$V_\phi$
DATA INPUT
1.5V
t
$t_{PLH}$
$t_{PHL}$
OPTICAL OUTPUT WITH MODE SELECT LOW
75%
$1/f_R$
$t_P$
25%
OPTICAL OUTPUT WITH MODE SELECT HIGH
75%
25%

**Figure 1. Flux Coding and Timing Diagram.**

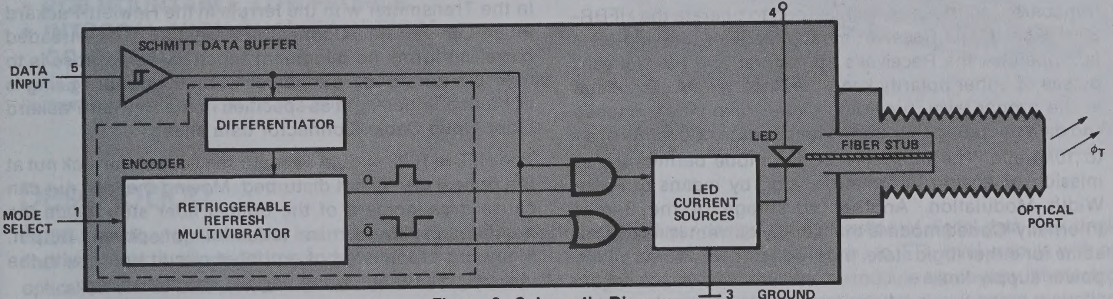

$V_{CC}$
4
SCHMITT DATA BUFFER
DATA INPUT
5
DIFFERENTIATOR
ENCODER
RETRIGGERABLE REFRESH MULTIVIBRATOR
Q
$\bar{Q}$
MODE SELECT
1
LED
LED CURRENT SOURCES
FIBER STUB
$\phi_T$
OPTICAL PORT
3
GROUND

**Figure 2. Schematic Diagram.**

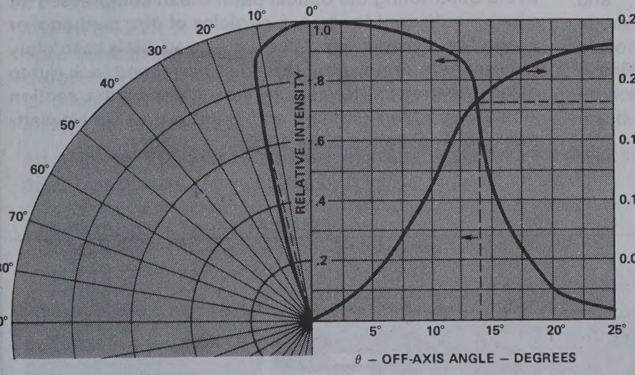


**Figure 3. Radiation Pattern.***

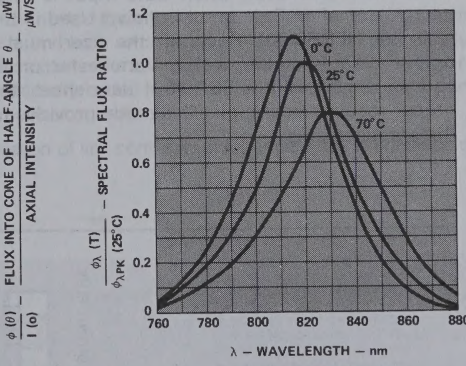


**Figure 4. Emission Spectrum.**

*The optical fiber is recessed within the barrel at a distance of approximately 7mm. Solid line represents radiation pattern from fiber stub without obscuration by connector barrel. Dashed line represents radiation pattern as seen from outside of connector.

Notes (cont'd):

3. Measured at a point 2mm (.079 in.) from where lead enters package.
4. A supply decoupling network of 2.2$\mu$H with 60$\mu$F is recommended.
5. With NRZ data, 10 Mbaud corresponds to a data rate of 10 Mbits/second. With other codes, the data rate is the baud rate divided by the number of code intervals per bit interval. Self-clocking code (e.g., Manchester) usually has two code intervals per bit interval giving 5 Mbits/second at 10 Mbaud.
6. With Hewlett-Packard HFBR-2001 and HFBR-3000 Series Cable/Connector Assembly.
7. For typical values, $V_{CC} = 5.00V$ and $T_A = 25°C$.
8. The transmitter output, $\phi_T$, equals the flux excursion, $\Delta\phi = (\phi_H - \phi_L)/2$. Notice that under the conditions specified for $\Delta\phi$, the average flux is $(\phi_H + \phi_L)/2$.
9. Flux excursion ratio, k, is the ratio of flux excursion above mid level to flux excursion below mid level.

$$k = \frac{\phi_H - \phi_M}{\phi_M - \phi_L}$$

10. Average currents for steady-state conditions at Data Input.
11. The refresh pulse is interrupted (abbreviated) if Data Input changes state during the refresh pulse. MAX propagation delay is for Data Input changing state during the maximum excursion of the refresh pulse.

## Electrical Description

The HFBR-1002 has two modes of operation: Internally-Coded mode and Externally-Coded mode. These are selected by making the Mode Select input "low" for Internally-Coded mode and "high" for Externally-Coded mode. With Mode Select "low," the optical signal generator in the HFBR-1002 produces a "mid-level" flux which has positive or negative excursions, depending on whether Data Input is "high" or "low". In this Internally-Coded mode, a train of positive excursions is initiated when Data Input goes "high;" when Data Input goes "low," a train of negative excursions is initiated. These excursions are pulses of approximately 40ns duration with a 400kHz repetition rate. Each initiation of a pulse train starts with a full-duration pulse, but when Data Input changes state, the train is terminated — even at mid-pulse — as a new train of opposite-polarity pulses is initiated. With this coding scheme and the low duty factor, the average flux is always near the mid-level, regardless of the data rate or duration in either state. This coding scheme, which is transparent to the user, is designed to operate the HFBR-2001 Fiber Optic Receiver most effectively; the mid-level flux operates the Receiver's dc-restorer and the "refresh" pulses of either polarity keep the Receiver's ALC voltage at the proper level, providing data format independence (no data encoding required) over the data rate range of dc to 10Mbaud. The Internally-Coded mode permits transmission of analog information, e.g., by means of Pulse Width Modulation. Another advantage of the 3-level Internally-Coded mode is that supply current is nearly the same for either logic state, thus reducing transients on the power supply line.

With Mode Select "high," the optical signal is at full maximum (~2 X mid-level) when Data Input is "high," and nearly zero when Data Input is "low." Used in this mode with the HFBR-2001 Receiver, the user must provide proper data formatting (e.g., Manchester or Bi-Phase coding, explained in HFBR-2001 data sheet) to ensure proper receiver operation. This mode provides for these three applications:

1. Steady state turn-on of the photo-emitter at maximum flux level (e.g., for system diagnosis).
2. Stand-by mode (e.g., when the system is not in use).
3. Transmission of 2-level optical signals from externally generated code (e.g., Manchester) for receivers not configured for the 3-level code. With Mode Select "high," the output is either $\phi_H$, or $\phi_L$. Direct analog operation is not possible due to hysteresis in the response of the optical signal to the Data Input signal.

## Mechanical and Thermal Considerations

Typical power consumption is less than 500mW so the transmitter can be mounted without consideration for external heat sinking. The optical port is an optical fiber stub centered in a metallic ferrule. This ferrule supports a split-wall cylindrical spring sleeve which aligns the ferrule in the Transmitter with the ferrule in the Hewlett-Packard Fiber Optic Cable/Connector Assembly. The threaded barrel performs no alignment function; its purpose is to hold the ferrule faces together when the coupling ring is tightened finger-tight as specified in the Hewlett-Packard Fiber Optic Cable/Connector data sheet.

The HFBR-1002 should be mounted so that the lock nut at the optical port is not disturbed. Moving the lock nut can cause misalignment of the optical fiber stub inside the module resulting in a reduction of power output. Mounting at the edge of a printed circuit board with the lock nut overhanging the edge is recommended.

Good system performance requires clean ferrule faces to avoid obstructing the optical path. Clean compressed air often is sufficient to remove particles of dirt; methanol or Freon™ on a cotton swab also works well. If it is absolutely necessary to remove the threaded barrel and lock nut to clean the transmitter ferrule face, refer to the section "Installation Measurement and Maintenance" in Hewlett-Packard Application Note 1000.

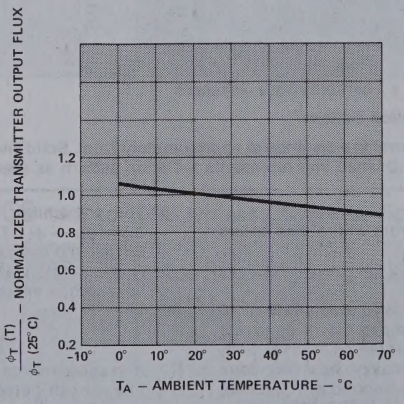


**Figure 5. Normalized Transmitter Output Flux vs. Temperature.**

**HEWLETT PACKARD**

# FIBER OPTIC HIGH PERFORMANCE RECEIVER MODULE

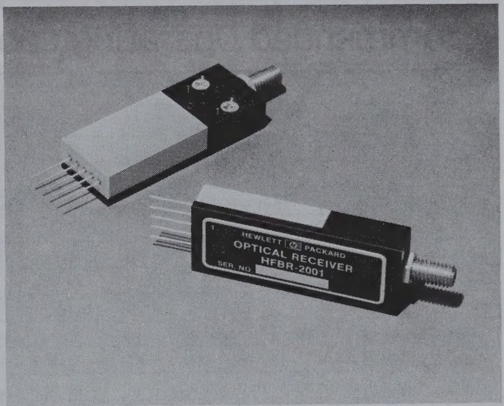
# HFBR-2001

TECHNICAL DATA FEBRUARY 1982

## Features

- DATA RATE: DC TO 10 Mbaud*
- LOW NOISE: $10^{-9}$ BER WITH 0.8 $\mu$W INPUT*
- NO DATA ENCODING REQUIRED*
- TTL OUTPUT LEVELS
- FUNCTIONAL LINK MONITORING*
- OPTICAL POWER INPUT INDICATION
- SINGLE +5V SUPPLY
- PCB MOUNTABLE, LOW PROFILE
- INTEGRAL, HIGH QUALITY OPTICAL CONNECTOR.

*When used with HFBR-1001/-1002 Transmitters and any Hewlett Packard HFBR-3000/-3100 Series Cable/Connector Assembly.


HEWLETT PACKARD
OPTICAL RECEIVER
HFBR-2001
SER. NO.

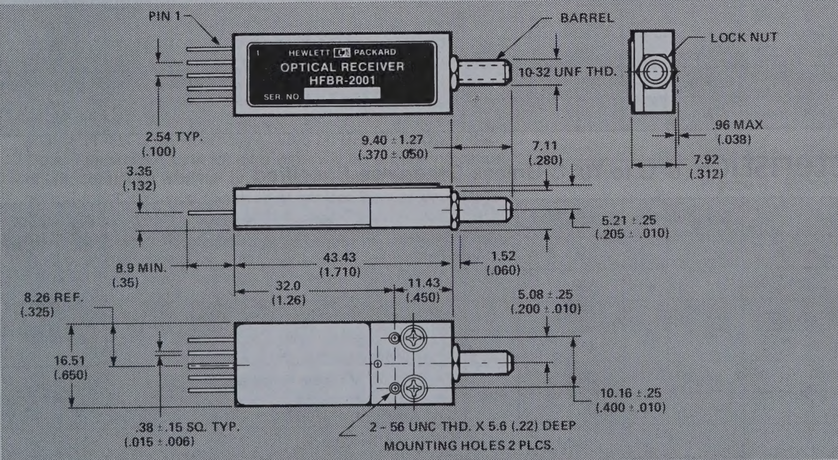
## Description

HFBR-2001 fiber optic receiver is an integrated optical to electrical transducer designed for reception of digital data over single fiber channels. A silicon PIN photodetector and a bipolar integrated circuit convert optical pulses to TTL level outputs with an optical sensitivity of .8 $\mu$W, and data rates to 10 Mb/s NRZ. An integral optical connector on the module allows easy interfacing without problems of fiber/detector alignment. The low profile package is designed for direct printed circuit board mounting without additional heat sinking.

The HFBR-2001 is intended for use with HFBR-3000 fiber optic cable/connector assemblies and the HFBR-1001/1002 fiber optic transmitters. In order to provide wide dynamic range, dc response, and high sensitivity, the receiver must periodically extract information from the optical waveform. When operating with a transmitter in the internally-coded mode, this information is automatically provided by the transmitter. When operating in the externally-coded mode, or with another transmission source, the user must provide proper data formatting to insure proper receiver operation.

An additional TTL output called Link Monitor (LM), provides a digital indication of link continuity independent of the presence of data. Link continuity is indicated by a logical high output state.

## Package Dimensions


PIN 1
BARREL
HEWLETT PACKARD
OPTICAL RECEIVER
HFBR-2001
SER. NO.
10-32 UNF THD.
LOCK NUT
2.54 TYP. (.100)
9.40 ± 1.27 (.370 ± .050)
7.11 (.280)
.96 MAX (.038)
7.92 (.312)
3.35 (.132)
5.21 ± .25 (.205 ± .010)
8.9 MIN. (.35)
43.43 (1.710)
1.52 (.060)
32.0 (1.26)
11.43 (.450)
8.26 REF. (.325)
5.08 ± .25 (.200 ± .010)
16.51 (.650)
10.16 ± .25 (.400 ± .010)
.38 ± .15 SQ. TYP. (.015 ± .006)
2 - 56 UNC THD. X 5.6 (.22) DEEP MOUNTING HOLES 2 PLCS.

CAUTION:

1. LOCK NUT AND BARREL SHOULD NOT BE DISTURBED.
2. SCREWS ENTERING THE 2-56 THREADED MOUNTING HOLES MUST NOT TOUCH BOTTOM.
3. THE HFBR-3000 CONNECTOR SHOULD NOT BE TIGHTENED BEYOND THE LIMITS SPECIFIED IN THE HFBR-3000 DATA SHEET.

| PIN | FUNCTION |
|---|---|
| 1 | TEST POINT |
| 2 | LINK MONITOR |
| 3 | GROUND |
| 4 | $V_{CC}$ |
| 5 | DATA OUTPUT |

NOTES:

1. DIMENSIONS IN mm (INCHES)
2. UNLESS OTHERWISE SPECIFIED THE TOLERANCE ON ALL DIMENSIONS IS ±.38mm (±.015")

# Absolute Maximum Ratings

| Parameter | | Symbol | Min | Max | Units | Note |
|---|---|---|---|---|---|---|
| Storage Temperature | | $T_S$ | -55 | 85 | °C | |
| Operating Temperature | | $T_A$ | 0 | 70 | °C | |
| Lead Soldering Cycle | Temperature | | | 260 | °C | 3 |
| | Time | | | 10 | s | |
| Supply Voltage | | $V_{CC}$ | -0.5 | 6.0 | V | |
| Output Voltage (High State) | | $V_{OH}$ | | 6.0 | V | |

# Recommended Operating Conditions

| Parameter | | | Symbol | Min | Max | Units | Note |
|---|---|---|---|---|---|---|---|
| Ambient Temperature | | | $T_A$ | 0 | 70 | °C | |
| Supply Voltage | | | $V_{CC}$ | 4.75 | 5.25 | V | |
| Supply Ripple (Peak-to-Peak) | | | $\Delta V_{CC}$ | | 250 | mV | 4 |
| High Level Output Current | Link Monitor | | $I_{OH}$ | | -100 | µA | |
| | Data Output | | | | -400 | | |
| Low Level Output Current | | | $I_{OL}$ | | 8 | mA | |
| Average Input Flux | | | $\phi_M$ | 0.8 | 70 | µW | 6 |
| Peak-to-Peak Input Flux | | | $\phi_H$-$\phi_L$ | 1.6 | 140 | µW | |
| Optical Input Pulse Duration and Timing | 2-Level Code | High Level | $t_H$ | 100 | 5000 | ns | |
| | | Low Level | $t_L$ | | | | |
| | Flux Excursion Ratio | | k | 0.75 | 1.25 | | 7 |
| | 3-Level Code | High Level | $t_H$ | 50 | | ns | 8 |
| | | Low Level | $t_L$ | | | | |
| | | Mid Level | $t_M$ | 0.05 | 6.7 | µs | |
| | Refresh Repetition Rate | | $f_R$ | 150 | | kHz | |
| | Refresh Duty Factor | | $f_R t_H, f_R t_L$ | | 0.04 | | |

# Electrical/Optical Characteristics 0° C to 70° C Unless Otherwise Specified

| Parameter | | | Symbol | Min | Typ$^5$ | Max | Units | Conditions | | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Output Voltage | High State | Data Output | $V_{OH}$ | 2.4 | 2.85 | | V | $\phi = (\phi_M + 0.8\ \mu W)$, $I_o = -400\ \mu A$ | $V_{CC} = 4.75$ V | 1, 2 | 7, 9 |
| | | Link Monitor | | | | | | $\Delta\phi = 0.8\ \mu W$, $I_o = -100\ \mu A$ | | | |
| | Low State | Data Output | $V_{OL}$ | | 0.35 | 0.5 | V | $\phi = (\phi_M - 0.8\ \mu W)$ | $I_o = 8$ mA<br>$V_{CC} = 4.75$ V | | |
| | | Link Monitor | | | 0.2 | 0.4 | | $\Delta\phi = 0$ | | | |
| Test Point Voltage | | | $V_T$ | | 0 | | V | $\phi_M = 100\ \mu W$ | | | 10 |
| | | | | | 1.3 | | | $\phi_M = 0$ | | | |
| Supply Current | | | $I_{CC}$ | | 77 | 100 | mA | $V_{CC} = 5.25$ V | | | |
| | | | | 60 | 77 | | | $V_{CC} = 4.75$ V | | | |
| Optical Port (fiber optic core) Diameter | | | $D_c$ | | 200 | | µm | | | | |
| Numerical Aperture | | | N.A. | | 0.5 | | | | | 3 | |
| Peak Responsivity Wavelength | | | $\lambda_p$ | | 770 | | nm | | | 4 | |

# Dynamic Characteristics 0° C to 70° C Unless Otherwise Specified

| Parameter | | | Symbol | Min | Typ$^5$ | Max | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay | High to Low | 3-Level Code | $t_{PHL}$ | | 29 | | ns | $V_{CC} = 4.75$ V, k = 1, Link Monitor High | 1 | 11 |
| | | 2-Level Code | | | 37 | | | | | |
| | Low to High | 3-Level Code | $t_{PLH}$ | | 37 | | ns | | | 12 |
| | | 2-Level Code | | | 45 | | | | | |
| Link Monitor Response Time | Low-to-High | | $t_{MH}$ | | 20 | | ms | $V_{CC} = 4.75$ V    $\Delta\phi = 0.8\ \mu W$ | | 13 |
| | High-to-Low | | $t_{ML}$ | | 1000 | | | $I_{OL} = 8$ mA    Peak-to-Peak | | 14 |
| Bit Error Rate at 10 M baud | | | BER | | | $10^{-9}$ | | k = 1, $\Delta\phi \geqslant 0.8\ \mu W$ | | 15 |

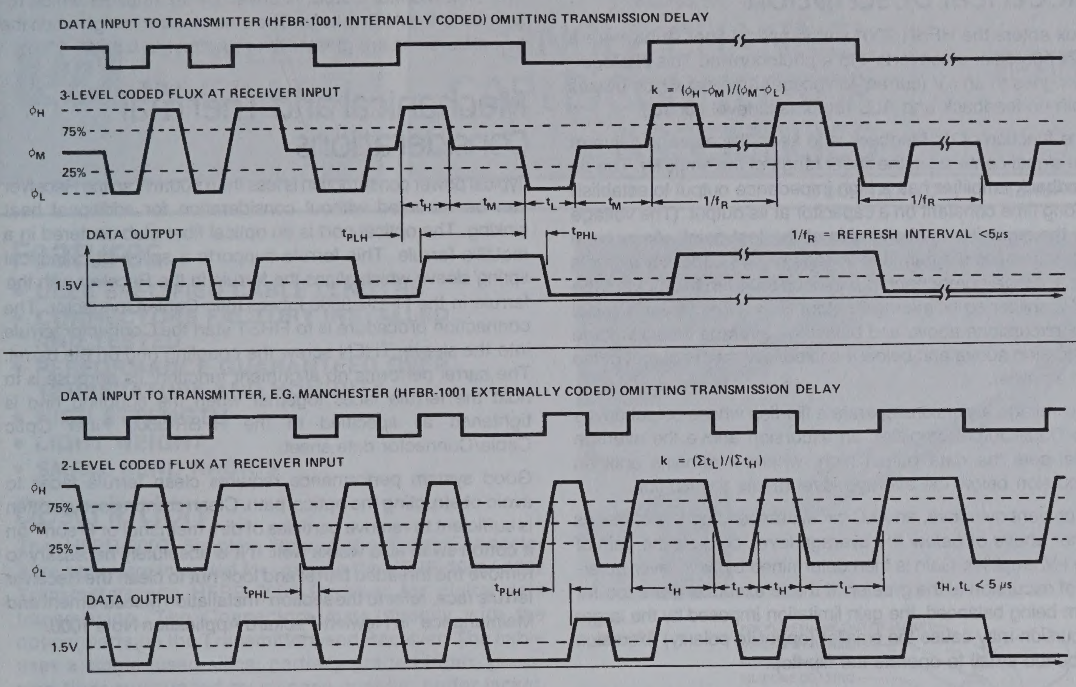


**Figure 1. Optical Input Timing Requirements.**

Notes (cont'd):

3. Measured at a point 2mm (.079″) from where the lead enters the package.
4. If ripple exceeds the specified limit, the regulator shown in Figure 5 should be used. The LC filter shown in Figure 5 is recommended whether the regulator is used or not.
5. For typical values, $V_{CC} = 5.00V$ and $T_A = 25°C$.
6. Flux is averaged over an interval of at least 50µs. Flux values specified are for the equivalent of a monochromatic source between 700nm and 820nm.
7. For either 2-level or 3-level code, $k = (\phi_H - \phi_M)/(\phi_M - \phi_L)$.
8. For the HFBR-2001, a *3-Level Code* is defined as having a mid-level, with equal-amplitude and pulse width excursions to high-level or to low-level.
9. Link Monitor provides a check of link continuity. A low Link Monitor output indicates that the optical signal path has been interrupted. For example, it might indicate a broken cable or a loose, dirty, or damaged connector. The link may still be operational with Link Monitor low, but it should be checked to determine the cause of the low indication. When the source of flux is an Internally-Coded HFBR-1001/1002 Fiber Optic Transmitter, Link Monitor high will be a valid indication of link continuity whether or not data is being transmitted. An optical input with excursions ($\Delta\phi$) greater than or equal to 0.8µW is sufficient to hold Link Monitor high.
10. When observing $V_T$, use a voltmeter with at least 10MΩ input resistance. With zero input flux, $V_T$ is at its maximum value, $V_{T,MAX}$. Then when flux is being received, whether modulated or not:

$$(V_{T,MAX} - V_T) = (25k\Omega)(I_p) = (25k\Omega)(R_\phi \phi_M)$$

where $I_p$ = average photodiode photocurrent
$R_\phi \approx 0.4A/W$ = photodiode responsivity
$\phi_M$ = average flux being received

11. Measured from the time at which optical input crosses the 25% level until DATA OUTPUT = 1.5V in HL transition.
12. Measured from the time at which optical input crosses the 75% level until DATA OUTPUT = 1.5V in LH transition.

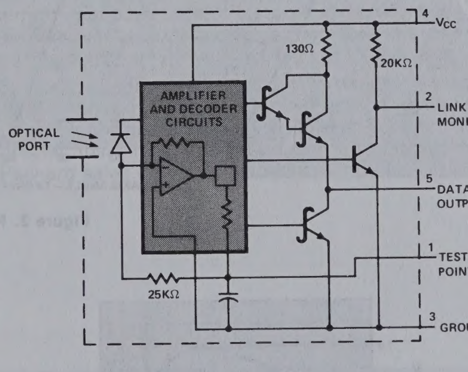


**Figure 2. Schematic Diagram.**

13. Measured from the time at which optical input fluctuation begins until LINK MONITOR rises to 1.5V.
14. Measured from the time at which optical input fluctuation ceases until LINK MONITOR falls to 1.5V.
15. With NRZ data, 10Mbaud corresponds to a data rate of 10Mb/s. With other codes, the data rate is the baud rate divided by the number of code intervals per bit interval—self-clocking code (e.g., Manchester) usually has two code intervals per bit interval giving 5Mb/s at 10Mbaud.

# Electrical Description

Flux enters the HFBR-2001 via an optical fiber stub where a PIN photodiode converts it to a photocurrent. This photocurrent goes to an I-V (current-to-voltage) amplifier which utilizes both dc feedback and ALC (automatic level control).

The function of dc feedback is to keep the average value of the signal centered in the linear range of the amplifier. The dc feedback amplifier has a high impedance output to establish a long time constant on a capacitor at its output. (The voltage on the capacitor is observable at the test point). As seen in the schematic diagram, the voltage on this capacitor extracts the *average* component of photocurrent from the input of the I-V amplifier so its *average* output is at a *fixed level.* Optical flux excursions above and below the average cause voltage excursion above and below the fixed level at the output of the I-V amplifier.

The voltage excursions operate a flip-flop whose output drives the Data Output amplifier; an excursion above the average level sets the data output high, where it remains until an excursion below the average level resets the flip-flop.

To prevent overdrive, an ALC circuit, responding to excursions *either above or below* the average level, controls the gain of the I-V amplifier. Gain is then determined by *whichever polarity* of excursion is the *greater*. If these excursions are too far from being balanced, the gain limitation imposed by the larger excursion may cause the smaller (opposite polarity) excursion to be too small to operate the flip-flop.

The Link Monitor output is driven by an amplifier which responds to the ALC voltage. The Link Monitor is high when the flux excursions are greater than or equal to 0.8µW.

# Mechanical and Thermal Considerations

Typical power consumption is less than 500mW so the Receiver can be mounted without consideration for additional heat sinking. The optical port is an optical fiber stub centered in a metallic ferrule. This ferrule supports a split-wall cylindrical spring sleeve which aligns the ferrule in the Receiver with the ferrule in the HFBR-3000 Fiber Optic Cable/Connector. The connection procedure is to FIRST start the Connector ferrule into the sleeve, THEN screw the coupling ring on the barrel. The barrel performs no alignment function; its purpose is to hold the ferrule faces together when the coupling ring is tightened as specified in the HFBR-3000 Fiber Optic Cable/Connector data sheet.

Good system performance requires clean ferrule faces to avoid obstructing the optical path. Clean compressed air often is sufficient to remove particles of dirt; methanol or Freon™ on a cotton swab also works well. If it is absolutely necessary to remove the threaded barrel and lock nut to clean the Receiver ferrule face, refer to the section "Installation Measurement and Maintenance" in Hewlett-Packard Application Note 1000.

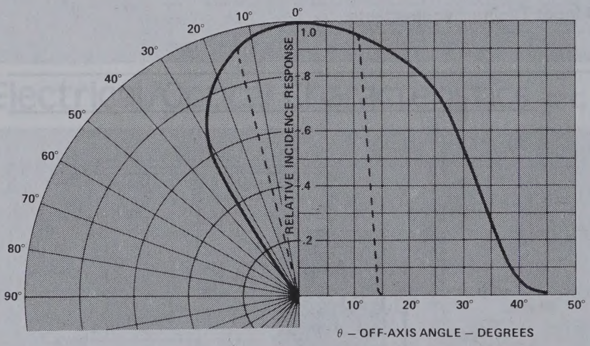


**Figure 3. Reception Pattern.***

*The optical fiber is recessed within the barrel at a distance of approximately 7mm. Solid line represents reception pattern at fiber stub without obscuration by connector barrel. Dashed line represents reception pattern as seen from outside of connector.

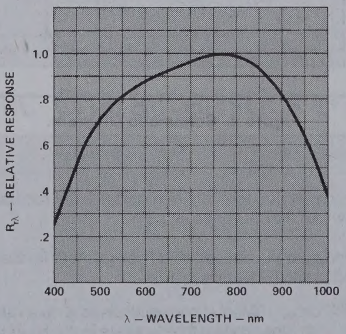


**Figure 4. Spectral Response.**

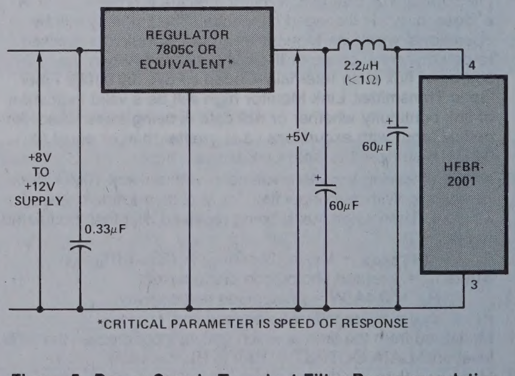


**Figure 5. Power Supply Transient Filter Recommendation.**

HEWLETT PACKARD

# FIBER OPTIC SINGLE CHANNEL CABLE/CONNECTOR ASSEMBLIES

## HFBR-3000

TECHNICAL DATA FEBRUARY 1982

## Features

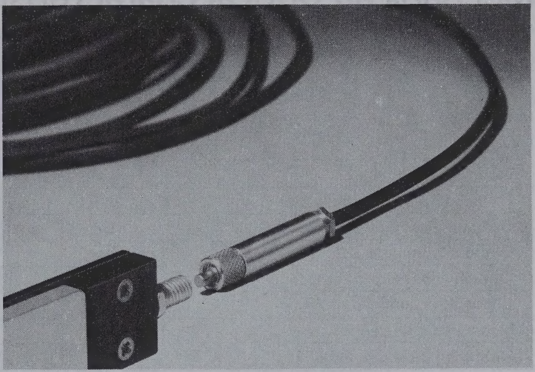
- USER SPECIFIED CABLE LENGTHS
- CONNECTORS FACTORY INSTALLED AND TESTED
- PERFORMANCE GUARANTEED OVER TEMPERATURE AND HUMIDITY
- HIGH STRENGTH
- LIGHT WEIGHT
- SMALL BEND RADIUS

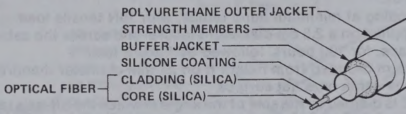
## Description

The HFBR-3000 Simplex Fiber Optic Cable/Connector Assemblies are intended for use with the HFBR-1001/-1002 Transmitters and HFBR-2001 Receiver for digital data transmission. The Connectors mate directly with the optical ports on the Transmitters and Receiver. The cable uses a single fused silica, partially graded index, glass-clad fiber surrounded by silicone coating, buffer jacket, and tensile strength members. This combination is then covered by a scuff-resistant outer jacket. The cable resistance to mechanical abuse, safety in flammable environments, and inherent absence of electromagnetic interference effects may make the use of conduit unnecessary. However, the light weight and high strength of these assemblies allows them to be drawn through most electrical conduits. The HFBR-3099 Adapter, for interconnecting cables, consists of two parts: a sleeve to align the ferrules and barrel to join the connector couplings.

**HFBR-3000 CABLE LENGTH TOLERANCE**

| Cable Length (Metres) | Tolerance | Units |
|---|---|---|
| 1—10 | +10 / −0 | % |
| 11—100 | +1 / −0 | Metre |
| > 100 | +1 / −0 | % |




POLYURETHANE OUTER JACKET
STRENGTH MEMBERS
BUFFER JACKET
SILICONE COATING
OPTICAL FIBER
CLADDING (SILICA)
CORE (SILICA)

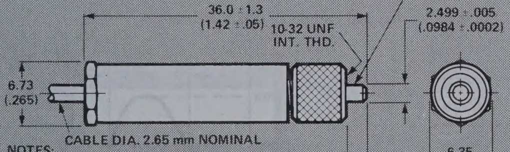
## Cable/Connector Ordering Guide

HFBR-3000 defines an optical cable of user specified length supplied with factory installed and tested connectors. Length must be specified in metres and can be any one metre increment from 1 to 1000 metres.

Systems intended to operate at distances greater than 1000 metres may require special component selection, depending upon operating conditions. For cable lengths greater than 1000 metres contact your local Hewlett-Packard sales office.

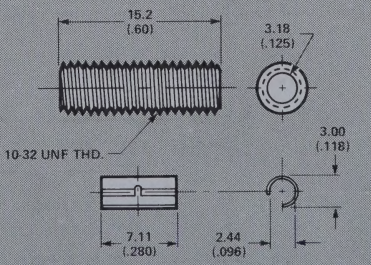
## Mechanical Dimensions

CONNECTOR


36.0 ± 1.3
(1.42 ± .05)
10-32 UNF
INT. THD.
FERRULE
2.499 ± .005
(.0984 ± .0002)
6.73
(.265)
CABLE DIA. 2.65 mm NOMINAL
6.35
(.250)
3.45
(.136)
REF. PLANE
FOR CABLE
LENGTH

NOTES:
1. DIMENSIONS ARE IN mm (INCHES).
2. UNLESS OTHERWISE SPECIFIED, THE TOLERANCES ARE:
   .X ± .51mm (.XX ± .02 in.)
   .XX ± .13mm (.XXX ± .005 in.)
3. FIBER END IS LOCKED FLUSH WITH FERRULE FACE.

HFBR-3099 ADAPTER


15.2
(.60)
3.18
(.125)
10-32 UNF THD.
3.00
(.118)
7.11
(.280)
2.44
(.096)

CAUTION:

A. COUPLING SHOULD NOT BE OVERTIGHTENED, SEE MECHANICAL/OPTICAL CHARACTERISTICS AND NOTE 14.

B. GOOD SYSTEM PERFORMANCE REQUIRES CLEAN FERRULE FACES TO AVOID OBSTRUCTING THE OPTICAL PATH. CLEAN COMPRESSED AIR OFTEN IS SUFFICIENT TO REMOVE PARTICLES. A COTTON SWAB SOAKED IN METHANOL OR FREON™ MAY ALSO BE USED.

# Absolute Maximum Ratings

| Parameter | | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|---|
| Relative Humidity at $T_A = 70°C$ | | | | 95 | % | 12 |
| Storage Temperature | | $T_S$ | -40 | +85 | °C | |
| Operating Temperature | | $T_A$ | -20 | +70 | | |
| Tensile Force | on Cable | $F_T$ | | 300 | N | 10 |
| | on Connector/Cable | | | 100 | | |

| Parameter | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|
| Bend Radius | r | 25 | | mm | 10,15 |
| Flexing | | | 50,000 | cycles | 4 |
| Crush Load | $F_C$ | | 200 | N | 5 |
| Impact | m | | 1 | kg | 6 |
| | h | | 0.3 | m | |

# Mechanical/Optical Characteristics

0° C to +70° C Unless Otherwise Specified

| Parameter | | Symbol | Min. | Typ. | Max. | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Exit Numerical Aperture | | N.A. | | 0.28 | | — | $\lambda = 820nm \;\; \ell \geq 300m$ | 1 | 7 |
| Insertion Loss | Length Dependent | $\alpha_O$ | | 16 | 20 | dB/km | $\lambda = 700nm \;\; \ell = 100m$ | 2 | 9.11 |
| | | | | 7 | 10 | | $\lambda = 820nm \;\; \ell > 300m$ | | |
| | Fixed | $\alpha_F$ | | 5.4 | 8.4 | dB | $\lambda = 820nm \;\; \ell \leq 300m$ | | 13,14 |
| Fiber Dispersion | | $\Delta t/\ell$ | | 17.5 | | ns/km | $700 < \lambda < 820nm$ | 3 | |
| Fiber 3dB Bandwidth | | $\Delta f \bullet \ell$ | | 20 | | MHz•km | | | 8 |
| Optical Fiber Core Diameter | | $D_C$ | | 100 | | μm | | | |
| Cladding Outside Diameter | | $D_{CL}$ | | 140 | | | | | |
| Optical Fiber Profile Index | | $\alpha_I$ | | 8 | | — | | | |
| Cable Structural Strength | | $F_C$ | | 2000 | | N | | | |
| Mass per Unit Length | | $m/\ell$ | | 6 | | kg/km | | | |
| Cable Outside Diameter | | $D_{CA}$ | | 2.65 | | mm | | | |

Notes (cont'd):

4. 180° bending at minimum bend radius, with 10N tensile load.
5. Force applied on a 2.5 cm diameter mandrel laid across the cable on a flat surface, for 100 hours, followed by flexure test.
6. For mass m dropped from height h on 25 mm diameter mandrel laid across the cable on a flat surface.
7. Exit N.A. is defined as the sine of the angle at which the off-axis radiant intensity is 10% of the axial radiant intensity.
8. Fiber 3dB Bandwidth • Length, (MHz • km) is defined as 350/fiber dispersion (ns/km).
9. Typical values are at $T_A = 25°C$.
10. This applies for short term testing, less than one hour.
11. Fiber loss exclusive of connector loss.
12. This applies to cable only.
13. When using HFBR-1002 transmitter with HFBR-3000 Cable/Connector Assembly, Total Insertion Loss, $\alpha_T = \alpha_F + \alpha_O \dfrac{(\ell - 300)}{1000}$ for $\ell > 300$ m; for lengths $\ell \leq 300$ m, $\alpha_T = \alpha_F$.
14. Coupling Ring "Finger Tight", torque $0.05 < L < 0.1$ N•m. Overtightening may cause excessive fiber misalignment or permanent damage.
15. The probability of a fiber weak point occurring at a point of maximum bend is small, consequently the risk of fiber breakage from exceeding the maximum curvature is extremely low.

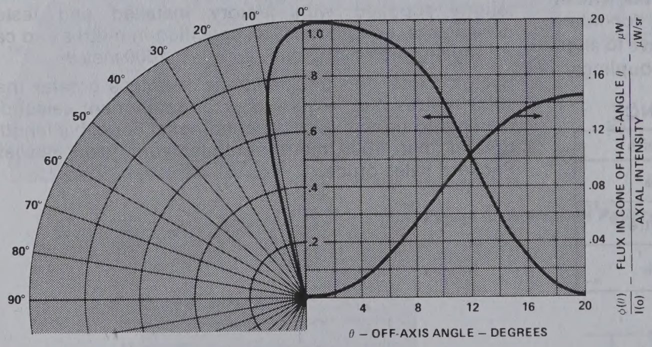


**Figure 1. Optical Fiber Output Radiation Pattern.**

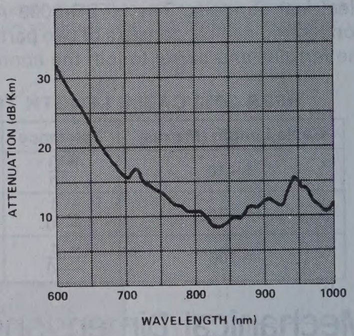
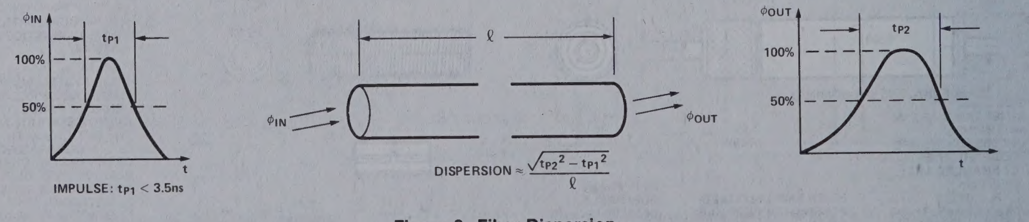


**Figure 2. Spectral Transmission.**

The actual fiber dispersion is determined from the RMS Pulse Spreading and can be approximated by:



$$\text{DISPERSION} \approx \frac{\sqrt{t_{P2}^{\,2} - t_{P1}^{\,2}}}{\ell}$$

**Figure 3. Fiber Dispersion**

**HEWLETT PACKARD**

# FIBER OPTIC DUAL CHANNEL CABLE/CONNECTOR ASSEMBLIES

**HFBR-3100**

TECHNICAL DATA FEBRUARY 1982

## Features

- DUPLEX ZIP CORD STRUCTURE
- CHARACTERIZED TO -40° C
- DESIGNED FOR FLAME RETARDENCY
- USER SPECIFIED CABLE LENGTHS
- CONNECTORS FACTORY INSTALLED AND TESTED
- HIGH STRENGTH
- LIGHT WEIGHT
- SMALL BEND RADIUS

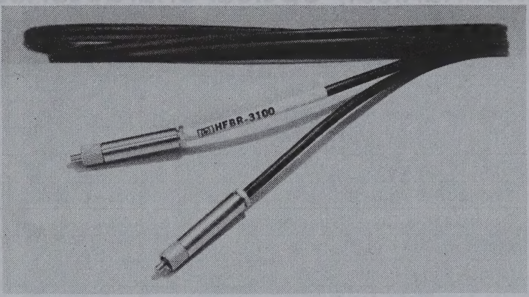
## Description

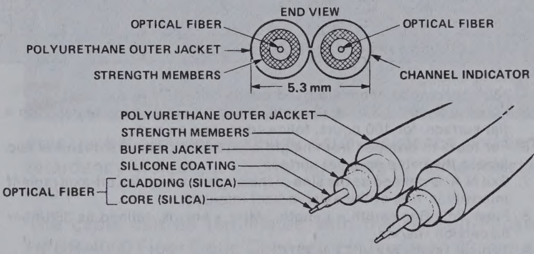
The HFBR-3100 Duplex Fiber Optic Cable/Connector Assemblies are intended for use with the HFBR-1001/-1002 Transmitters and HFBR-2001 Receiver for digital data transmission. The Connectors mate directly with the optical ports on the Transmitters and Receiver. Each channel uses a single fused silica, partially graded index, glass-clad fiber surrounded by silicone coating, buffer jacket, and tensile strength members. This combination is then covered by a scuff-resistant outer jacket. The two channels are connected by an easily separated zip-cord structure which also provides channel identification by an extruded ridge on one side.

The cable resistance to mechanical abuse, safety in explosive environments, and inherent absence of electromagnetic interference effects may make the use of conduit unnecessary. However, the light weight and high strength of these assemblies allows them to be drawn through most electrical conduits. The HFBR-3099 Adapter, for interconnecting cables, consists of two parts: a sleeve to align the ferrules and barrel to join the connector couplings.

**HFBR-3100 CABLE LENGTH TOLERANCE**

| Cable Length (Metres) | Tolerance |
|---|---|
| 1-10 | +10/-0 % |
| 11-100 | +1/-0 Metre |
| > 100 | +1/-0 % |



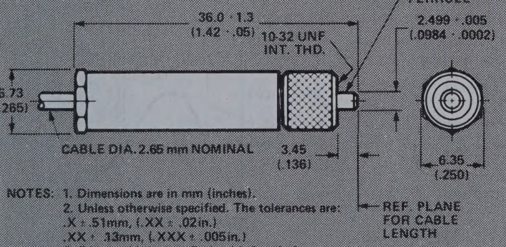

END VIEW
OPTICAL FIBER
OPTICAL FIBER
POLYURETHANE OUTER JACKET
STRENGTH MEMBERS
CHANNEL INDICATOR
5.3 mm
POLYURETHANE OUTER JACKET
STRENGTH MEMBERS
BUFFER JACKET
SILICONE COATING
OPTICAL FIBER
CLADDING (SILICA)
CORE (SILICA)

## Cable/Connector Ordering Guide

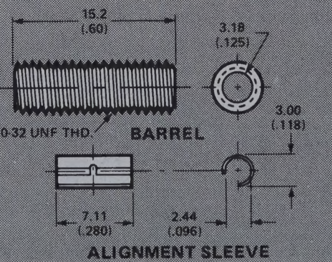
HFBR-3100 defines an optical cable of user specified length supplied with factory installed and tested connectors. Length must be specified in metres and can be any one metre increment from 1 to 1000 metres.

Systems intended to operate at distances greater than 1000 metres may require special component selection, depending upon operating conditions. For cable lengths greater than 1000 metres contact your local Hewlett-Packard sales office.

## Mechanical Dimensions


CONNECTOR
FERRULE
36.0 ± 1.3
(1.42 ± .05)
10-32 UNF
INT. THD.
2.499 ± .005
(.0984 ± .0002)
6.73
(.265)
CABLE DIA. 2.65 mm NOMINAL
3.45
(.136)
6.35
(.250)
REF. PLANE
FOR CABLE
LENGTH

NOTES:
1. Dimensions are in mm (inches).
2. Unless otherwise specified. The tolerances are:
   .X ± .51mm, (.XX ± .02in.)
   .XX ± .13mm, (.XXX ± .005in.)
3. Fiber end is locked flush with ferrule face.


HFBR-3099 ADAPTER
15.2
(.60)
3.18
(.125)
10-32 UNF THD.
BARREL
3.00
(.118)
7.11
(.280)
2.44
(.096)
ALIGNMENT SLEEVE

CAUTION:
A. Coupling should not be overtightened, see mechanical/optical characteristics and note 14.
B. Good system performance requires clean ferrule faces to avoid obstructing the optical path. Clean compressed air often is sufficient to remove particles. A cotton swab soaked in methanol or Freon™ may also be used.

# Absolute Maximum Ratings

| Parameter | | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|---|
| Relative Humidity at $T_A = 70°C$ | | | | 95 | % | 12 |
| Storage Temperature | | $T_S$ | -40 | +85 | °C | 15 |
| Operating Temperature | | $T_A$ | -20 | +70 | | |
| Tensile Force | per Cable Channel | $F_T$ | | 300 | N | 10 |
| | on Connector/Cable | | | 100 | | |

| Parameter | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|
| Bend Radius | r | 25 | | mm | 10,16 |
| Flexing | | | 50,000 | cycles | 4 |
| Crush Load | $F_C$ | | 200 | N | 5 |
| Impact | m | | 1 | kg | 6 |
| | h | | 0.3 | m | |

# Mechanical/Optical Characteristics

-20°C to +70°C Unless Otherwise Specified

| Parameter | | Symbol | Min. | Typ. | Max. | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Exit Numerical Aperture | | N.A. | | 0.28 | | — | $\lambda = 820nm \quad \ell \geq 300m$ | 1 | 7 |
| Insertion Loss | Length Dependent | $\alpha_O$ | | 16 | 20 | dB/km | $\lambda = 700nm \quad \ell = 100m$ | 2 | 9,11 |
| | | | | 7 | 10 | | $\lambda = 820nm \quad \ell > 300m$ | | |
| | Fixed | $\alpha_F$ | | 5.4 | 8.4 | dB | $\lambda = 820nm \quad \ell \leq 300m$ | | 13,14 |
| Fiber Dispersion | | $\Delta t/\ell$ | | 17.5 | | ns/km | $700 < \lambda < 820nm$ | 3 | |
| Fiber 3dB Bandwidth | | $\Delta f \bullet \ell$ | | 20 | | MHz•km | | | 8 |
| Optical Fiber Core Diameter | | $D_C$ | | 100 | | μm | | | |
| Cladding Outside Diameter | | $D_{CL}$ | | 140 | | | | | |
| Optical Fiber Profile Index | | $\alpha_I$ | | 8 | | — | | | |
| Cable Structural Strength | | $F_C$ | | 2000 | | N | | | |
| Mass per Unit Length | | $m/\ell$ | | 17 | | kg/km | | | |
| Cable Outside Diameter (each Channel) | | $D_{CA}$ | | 2.65 | | mm | | | |

Notes (cont'd):

4. 180° bending at minimum bend radius, with 10N tensile load.
5. Force applied on 2.5 cm diameter mandrel laid across the cable on a flat surface, for 100 hours, followed by flexure test.
6. For mass m dropped from height h on 25 mm diameter mandrel laid across the cable on a flat surface.
7. Exit N.A. is defined as the sine of the angle at which the off-axis radiant intensity is 10% of the axial radiant intensity.
8. Fiber 3dB Bandwidth • Length, (MHz • km) is defined as 350/fiber dispersion (ns/km).
9. Typical values are at $T_A = 25°C$.
10. This applies for short term testing, less than one hour.
11. Fiber loss exclusive of connector loss.
12. This applies to cable only.
13. When using HFBR-1002 transmitter with HFBR-3100 Cable/Connector Assembly, Total Insertion Loss, $\alpha_T = \alpha_F + \alpha_O \left(\frac{\ell - 300}{1000}\right)$ for $\ell > 300$ m; for lengths $\ell \leq 300$ m, $\alpha_T = \alpha_F$.
14. Coupling Ring "Finger Tight", torque $0.05 < L < 0.1$ N•m. Overtightening may cause excessive fiber misalignment or permanent damage.
15. Maximum Storage Temperature at 85°C < 1000 hrs.
16. The probability of a fiber weak point occuring at a point of maximum bend is small, consequently the risk of fiber breakage from exceeding the maximum curvature is extremely low.

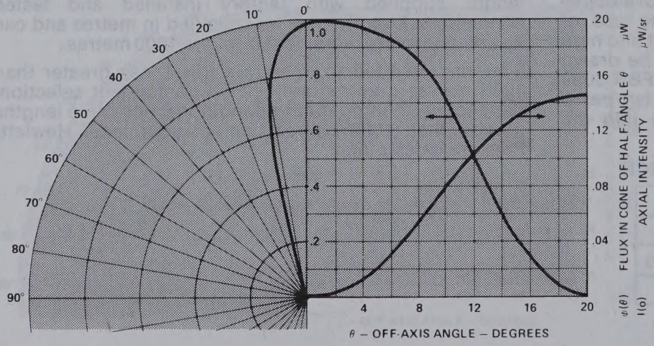


**Figure 1. Optical Fiber Output Radiation Pattern.**

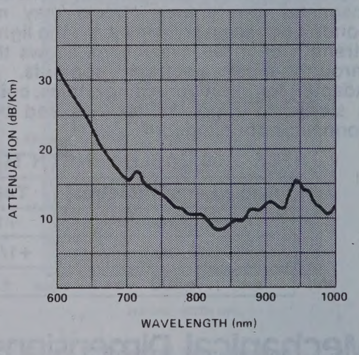


**Figure 2. Spectral Transmission.**

The actual fiber dispersion is determined from the RMS Pulse Spreading and can be approximated by:

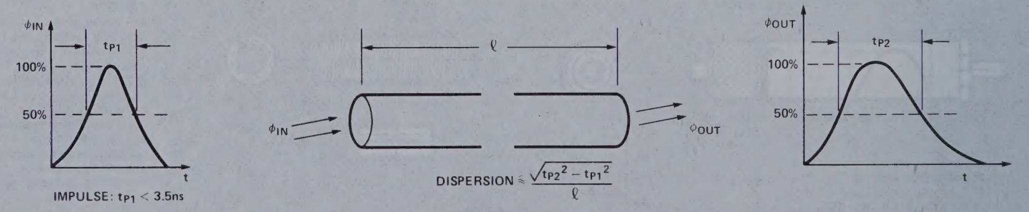


**Figure 3. Fiber Dispersion**

**HEWLETT PACKARD**

# FIBER OPTIC CABLE

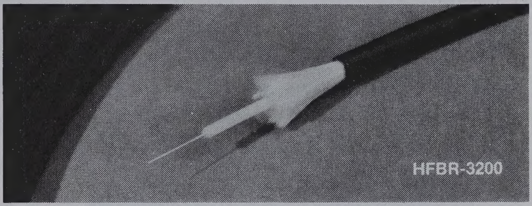
## HFBR-3200
SINGLE CHANNEL

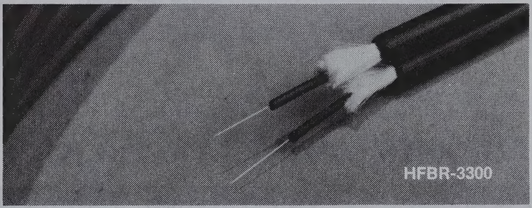
## HFBR-3300
DUAL CHANNEL

TECHNICAL DATA FEBRUARY 1982

## Features

- **STANDARD 100/140 μm GLASS OPTICAL FIBER**
- **USER-SPECIFIED CABLE LENGTHS**
- **GUARANTEED PERFORMANCE OVER TEMPERATURE AND HUMIDITY**
- **HIGH STRENGTH**
- **LIGHT WEIGHT**
- **SMALL BEND RADIUS**
- **COMPATIBLE WITH HFBR-4000 CONNECTORS**
- **SINGLE OR DUAL CHANNEL CABLE**





## Description

The HFBR-3200 Single Channel Fiber Optic cable is constructed of a single partially graded index glass fiber contained within a buffer jacket, wrapped with aramid strength members, and covered with a scuff-resistant polyurethane outer jacket.

The HFBR-3300 Dual Channel Fiber Optic cable has two glass fibers, each in a cable of construction similar to the single channel cable, joined together with a web. The individual channels are easily separated for connectoring, and are identified with a marking on one channel of the cable.

The optical waveguide is a fused silica glass, partially graded index fiber, which gives low attenuation and a wide bandwidth. The silicone and buffer jackets protect the fiber from being scratched and provide a base for the helically wrapped aramid strength members.

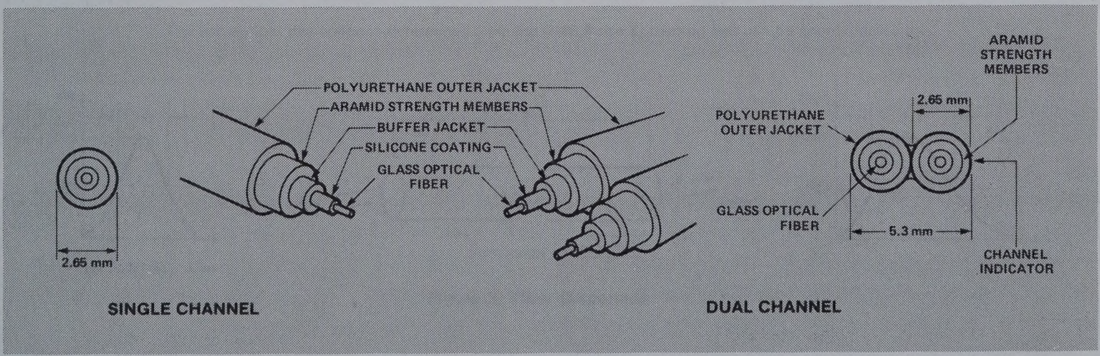
The aramid strength members have high tensile strength, and a high strength to weight ratio. The tough polyurethane outer jacket provides flexibility, scuff-resistance, and flame retardancy yielding a strong, lightweight, flame resistant cable.

The cable can be terminated with the Hewlett-Packard HFBR-4000 Fiber Optic Connector in less than 20 minutes by an experienced user with suitable tooling, such as the Hewlett-Packard HFBR-0100 Connector Assembly Tooling Kit.

## Applications

Resistance to mechanical abuse and harsh environments, safety in flammable environments, and immunity from electromagnetic interference effects make the HFBR-3200/3300 Fiber Optic Cable ideal for many applications. While the use of conduit may not be necessary, the cable's light weight and high strength allow it to be drawn through most electrical conduit.

## Fiber Optic Cable Construction


POLYURETHANE OUTER JACKET
ARAMID STRENGTH MEMBERS
BUFFER JACKET
SILICONE COATING
GLASS OPTICAL FIBER
2.65 mm
SINGLE CHANNEL
ARAMID STRENGTH MEMBERS
POLYURETHANE OUTER JACKET
2.65 mm
GLASS OPTICAL FIBER
5.3 mm
CHANNEL INDICATOR
DUAL CHANNEL

## Installation

Hewlett-Packard Fiber Optic cable is designed so that when pulled through conduit, accepted wire pulling methods and tools, such as a cable grip, can be used. However, a few precautions for optical cable are necessary: the cable must not be bent tighter than its minimum bend radius; the tensile strength of the cable should not be exceeded (a cable lubricant can be used to minimize the drawing force); tensile load should be applied only to the cable and not the connector.

### CABLE LENGTH TOLERANCE

| Cable Length (Metres) | Tolerance |
|---|---|
| 1-10 | +10/-0 % |
| 11-100 | +1/-0 Metre |
| > 100 | +1/-0 % |

## Cable Ordering Guide

The HFBR-3200 Single Channel and HFBR-3300 Dual Channel Optical Cable are produced to user specified lengths. The length must be specified in metres and can be any one metre increment from 1 to 1000 metres. For continuous lengths greater than 1000 metres, contact your Hewlett-Packard sales office.

## Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|
| Relative Humidity at $T_A = 70°C$ | | | 95 | % | |
| Storage Temp. | $T_S$ | -40 | +85 | °C | |
| Operating Temp. | $T_A$ | -20 | +70 | | |
| Bend Radius, No Load | r | 25 | | mm | 9,12 |
| Flexing | | 50k | | Cycles | 1 |

| Parameter | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|
| Crush Load | $F_C$ | | 200 | N | 2 |
| Impact | m | | 1 | kg | 3 |
| | h | | 0.3 | m | |
| Tensile Load Without Bends | $F_T$ | | 300 | N | 10,8,9 |
| | | | 600 | | 11,8,9 |

## Mechanical/Optical Characteristics -20° C to +70° C Unless Otherwise Specified

| Parameter | | Symbol | Min. | Typ.[6] | Max. | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Exit Numerical Aperture | | N.A. | | .28 | | — | $\lambda = 820nm$ $\ell \geq 300m$ | 1 | 4 |
| Attenuation | | $\alpha_o$ | | 16 | 20 | dB/km | $\lambda = 700nm$ $\ell = 100m$ | 2 | 6,7 |
| | | | | 7 | 10 | | $\lambda = 820nm$ $\ell > 300m$ | | |
| Fiber Dispersion | | $\Delta t/\ell$ | | 17.5 | | ns/km | $700 < \lambda < 820nm$ | 3 | |
| Fiber 3dB Bandwidth | | $\Delta f \cdot \ell$ | | 20 | | MHz•km | | | 5 |
| Optical Fiber Core Diameter | | $D_C$ | | 100 | | µm | | | |
| Cladding Outside Diameter | | $D_{CL}$ | | 140 | | | | | |
| Optical Fiber Profile Index | | $\alpha_I$ | | 8 | | — | | | |
| Cable Structural Strength | | $F_C$ | | 2000 | | N | | | |
| Mass per Unit Length | Single Channel | $m/\ell$ | | 8 | | kg/km | | | |
| | Dual Channel | | | 17 | | | | | |

1. 180° bending at minimum bend radius, with 10N tensile load.
2. Force applied on 2.5 cm diameter mandrel laid across the cable on a flat surface, for 100 hours, followed by flexure test.
3. For mass m dropped from height h on 25 mm diameter mandrel laid across the cable on a flat surface.
4. Exit N.A. is defined as the sine of the angle at which the off-axis radiant intensity is 10% of the axial radiant intensity.
5. Fiber 3dB Bandwidth • Length, (MHz • km) is defined as 350/fiber dispersion (ns/km).
6. Typical values are at $T_A = 25°C$.
7. Fiber loss exclusive of connector loss.
8. One Newton equals approximately 0.225 pounds force.
9. Short term, ≤ 1 hr.
10. Single channel.
11. Dual channel.
12. The probability of a fiber weak point occurring at a point of maximum bend is small, consequently the risk of fiber breakage from exceeding the maximum curvature is extremely low.

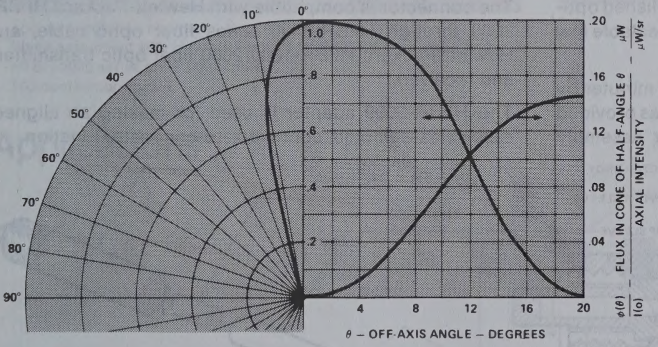


**Figure 1. Optical Fiber Output Radiation Pattern.**

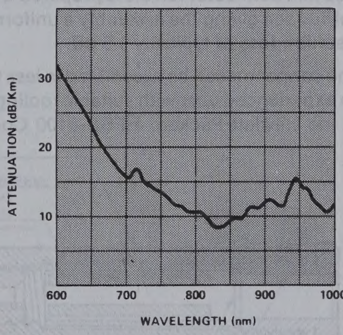


**Figure 2. Spectral Transmission.**

The actual fiber dispersion is determined from the RMS Pulse Spreading and can be approximated by:

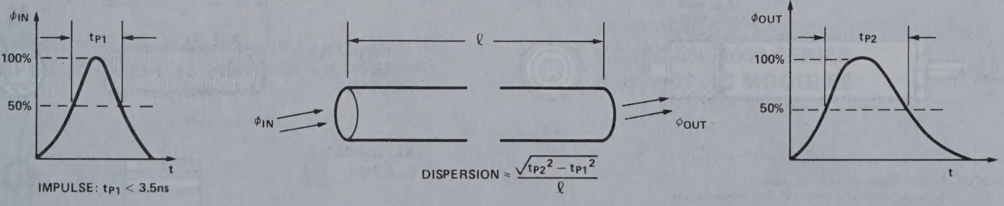


**Figure 3. Fiber Dispersion**

HEWLETT PACKARD

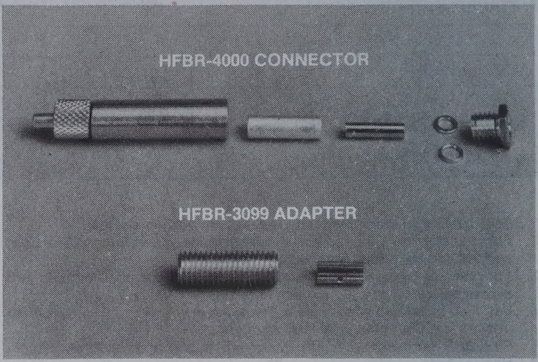
# FIBER OPTIC CONNECTOR

# HFBR-4000
CONNECTOR
# HFBR-3099
ADAPTER

TECHNICAL DATA FEBRUARY 1982

## Features

- **TERMINATES HEWLETT-PACKARD 100/140 μm FIBER OPTIC CABLE**
- **TYPICAL INSERTION LOSS 1.5 dB**
- **ALL METAL PIECE-PARTS**
- **SIMPLE, RAPID ASSEMBLY**
- **STANDARD 2.50 mm FERRULE**
- **WIDE OPERATING TEMPERATURE RANGE**
- **COMPACT SIZE**


HFBR-4000 CONNECTOR
HFBR-3099 ADAPTER

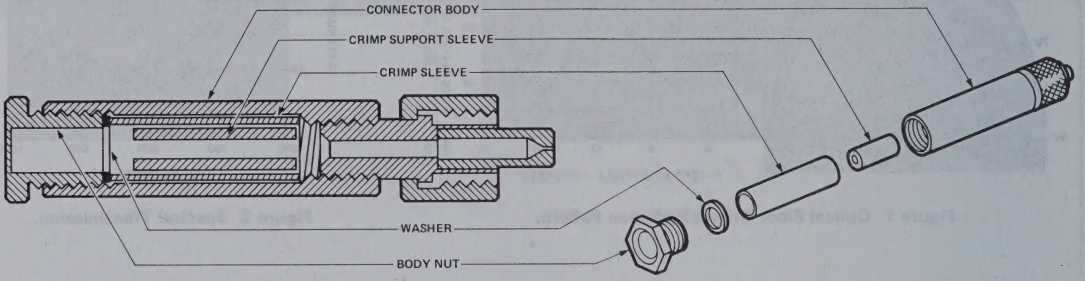
## Description

The HFBR-4000 Fiber Optic Connector is constructed of all metal piece-parts and has been designed to use a high performance epoxy to stake the optical fiber. The standard, 2.50 mm connector ferrule is prepared with a polished optical surface giving the assembly a uniformly repeatable low insertion-loss of typically 1.5 dB.

The connector can be assembled in less than 20 minutes by an experienced user with suitable tooling, such as provided in the Hewlett-Packard HFBR-0100 Connector Assembly Tooling Kit. When properly assembled, the connector has excellent strength and repeatable performance over a wide temperature range.

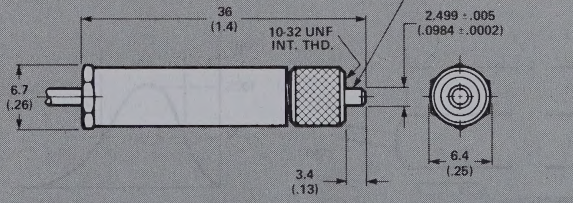
The connector is compatible with Hewlett-Packard HFBR-3000 through HFBR-3400 series fiber optic cable, and Hewlett-Packard HFBR-1000/2000 fiber optic transmitters and receivers.

The HFBR-3099 adapter is used for making an aligned, easily disassembled, connector-to-connector junction.


CONNECTOR BODY
CRIMP SUPPORT SLEEVE
CRIMP SLEEVE
WASHER
BODY NUT

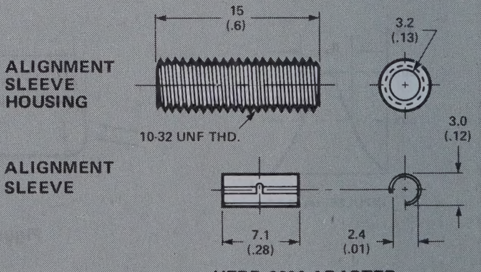
**CONNECTOR ASSEMBLY**

## Mechanical Details


FERRULE (SEE NOTE 3)
36
(1.4)
10-32 UNF
INT. THD.
2.499 ± .005
(.0984 ± .0002)
6.7
(.26)
6.4
(.25)
3.4
(.13)

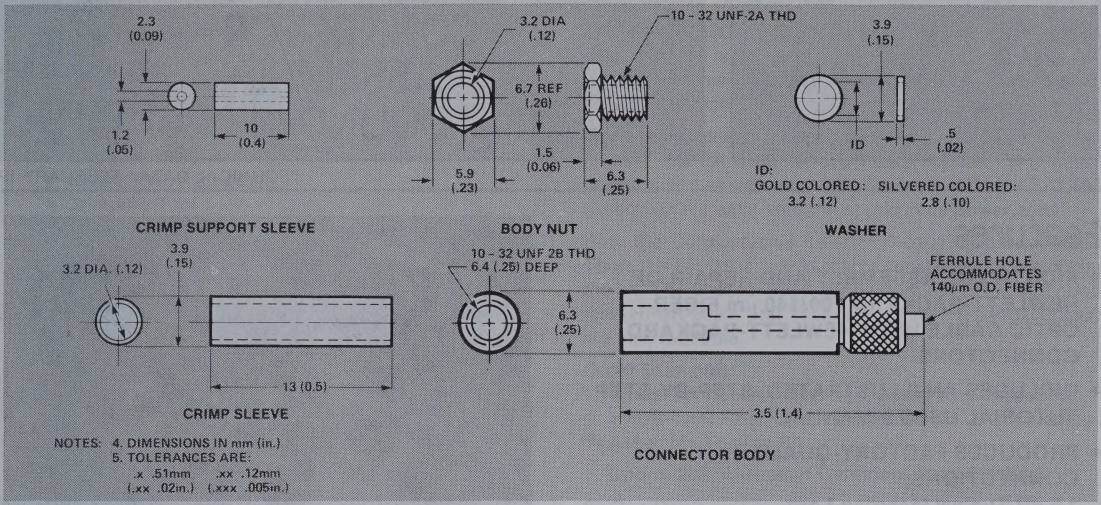
NOTES: 1. Dimensions are in mm (inches).
2. Unless otherwise specified. The tolerances are:
.X ± .51mm, (.XX ± .02in.)
.XX ± .13mm, (.XXX ± .005in.)
3. Ferrule hole accomodates 140μm O.D. fiber.

**ASSEMBLED HFBR-4000 CONNECTOR**


ALIGNMENT SLEEVE HOUSING
15
(.6)
3.2
(.13)
10-32 UNF THD.
3.0
(.12)
ALIGNMENT SLEEVE
7.1
(.28)
2.4
(.01)

**HFBR-3099 ADAPTER**

# Connector Piece-Parts


2.3
(0.09)
1.2
(.05)
10
(0.4)
CRIMP SUPPORT SLEEVE
3.2 DIA
(.12)
10 - 32 UNF-2A THD
6.7 REF
(.26)
1.5
(0.06)
5.9
(.23)
6.3
(.25)
BODY NUT
3.9
(.15)
ID
.5
(.02)
ID:
GOLD COLORED: 3.2 (.12)
SILVERED COLORED: 2.8 (.10)
WASHER
3.2 DIA. (.12)
3.9
(.15)
13 (0.5)
CRIMP SLEEVE
10 - 32 UNF 2B THD
6.4 (.25) DEEP
6.3
(.25)
FERRULE HOLE ACCOMMODATES 140μm O.D. FIBER
3.5 (1.4)
CONNECTOR BODY

NOTES: 4. DIMENSIONS IN mm (in.)
5. TOLERANCES ARE:
.x .51mm .xx .12mm
(.xx .02in.) (.xxx .005in.)

## Absolute Maximum Ratings

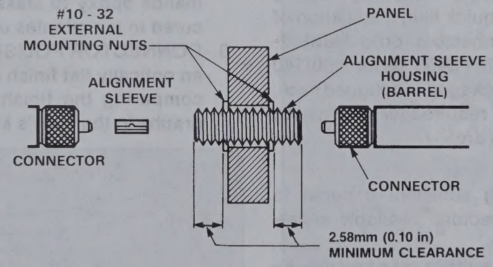
| Parameter | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|
| Storage Temp. | $T_S$ | -40 | +85 | °C | 7 |
| Operating Temp. | $T_A$ | -20 | +70 | °C | 7 |
| Tensile Force | $F_T$ |  | 100 | N | 7 |

6. $\alpha_{CC}$, connector-to-connector loss; measured steady state.
7. When assembled with Hewlett-Packard HFBR-0100 procedure and HFBR-3000 series glass fiber cable.
8. 100 connection cycles.

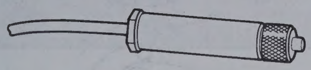
## Optical Characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Units | Note |
|---|---|---|---|---|---|---|
| Insertion Loss | $\alpha_{CC}$ |  | 1.5 |  | dB | 6,7 |
| Insertion Loss Repeatability | $\Delta\alpha_{CC}$ |  | 0.2 |  | dB | 8 |

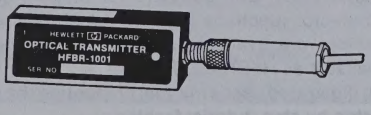
## Applications


#10 - 32
EXTERNAL
MOUNTING NUTS
PANEL
ALIGNMENT SLEEVE
HOUSING
(BARREL)
ALIGNMENT
SLEEVE
CONNECTOR
CONNECTOR
2.58mm (0.10 in)
MINIMUM CLEARANCE

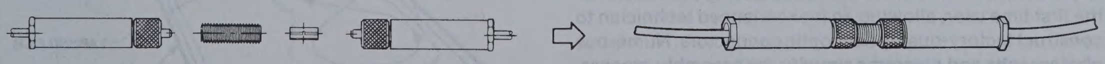
- **BULKHEAD OR PANEL MOUNTING OF HFBR-4000 CONNECTORS**



- **TERMINATION FOR HEWLETT-PACKARD HFBR-3000 SERIES FIBER OPTIC CABLE**


HEWLETT PACKARD
OPTICAL TRANSMITTER
HFBR-1001
SER NO

- **INTERFACE TO HEWLETT-PACKARD HFBR-1000/2000 SERIES FIBER OPTIC MODULES**



- **CONNECTOR-TO-CONNECTOR INTERFACE**

HEWLETT PACKARD

# FIBER OPTIC CONNECTOR ASSEMBLY TOOLING KIT

**HFBR-0100**
**TOOLING KIT**

**HFBR-0101**
**CONSUMABLES KIT**

**HFBR-0102**
**CUSTOM TOOLS**

TECHNICAL DATA FEBRUARY 1982

## Features

- **AIDS IN THE ASSEMBLY AND REPAIR OF HEWLETT-PACKARD 100/140 μm FIBER OPTIC CABLE WITH HEWLETT-PACKARD CONNECTORS**
- **INCLUDES AN ILLUSTRATED, STEP-BY-STEP TUTORIAL USER'S MANUAL**
- **PRODUCES FACTORY-QUALITY CONNECTIONS;**
  **1.5 dB Typical Insertion Loss**
- **COMPLETE — INCLUDES ALL TOOLS, MATERIALS AND CONNECTOR PARTS REQUIRED TO ASSEMBLE 10 CONNECTORS**
- **RAPID, LESS THAN 20 MINUTE CONNECTOR ASSEMBLY TIME WITH EXPERIENCE**
- **PACKAGED IN A RUGGED CASE**

## Description

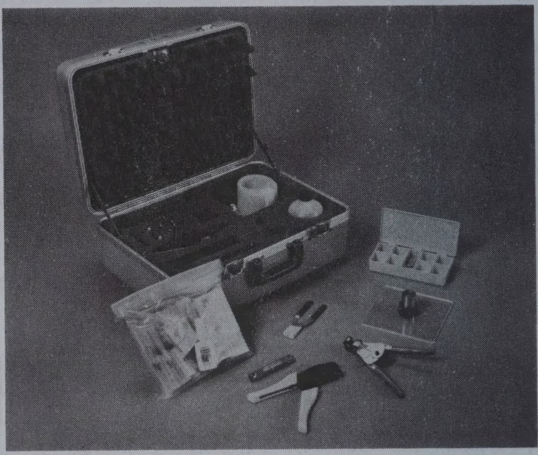
The HFBR-0100 Fiber Optic Connector Assembly Tooling Kit is a complete kit designed for quick field installation of Hewlett-Packard HFBR-4000 connectors onto Hewlett-Packard HFBR-3000 through HFBR-3400 series 100/140 μm optical fiber cable. The kit is packaged in a rugged case, supplying the user with everything required for terminating the fiber optic cable. The contents are:

1. A set of common connectoring tools
2. A consumables kit containing sufficient material to assemble ten fiber optic connectors (available separately as HFBR-0101).
3. A set of custom tools (available separately as HFBR-0102).
4. A set of connector piece-parts for terminating ten connector ends, and adapters for making connector-to-connector junctions (the individual unassembled connectors are available as HFBR-4000; the adapter is available as HFBR-3099).
5. An illustrated user's manual presenting the procedure in a step by step, tutorial fashion.

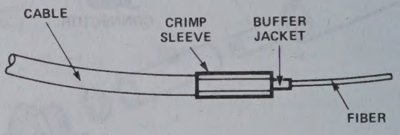
## User's Manual Outline

The User's Manual details the connectoring procedure for the first time user, allowing an inexperienced technician to construct factory-quality fiber optic connectors. Numerous photographs and diagrams simplify the assembly process.

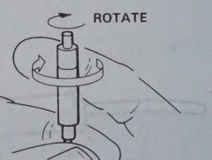
The User's Manual is composed of three major sections, described as follows:



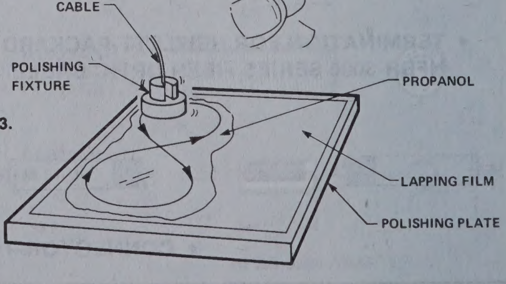
1. CABLE PREPARATION: The fiber optic cable is stripped of its jackets, and the strength members are terminated by the installation of crimp hardware.
2. CONNECTOR ASSEMBLY: The prepared cable end is assembled into the connector body using a high performance epoxy to stake the optical fiber. The epoxy is cured in ten minutes using the supplied heater.
3. CONNECTOR POLISHING: The fiber end is ground to an optically flat finish and inspected with a microscope comparing the finish with the detailed photomicrographs in the User's Manual.



1.



2.



3.

# HFBR-0100 Materials List

1. COMMON CONNECTORING TOOLS WITH CASE
    - Diagonal Cutters
    - No-Nik™ Strippers
    - Scissors
    - 50X Microscope
    - Safety Glasses
    - 16 AWG Wire Strippers
    - Crimping Tool
    - Polishing Plate
    - Heater:
      (option 001) 100-120 VAC 50/60 Hz
      (option 2XX) 200-240 VAC 50/60 Hz
2. TEN HFBR-4000 CONNECTORS WITH SIX HFBR-3099 ADAPTERS
3. HFBR-0101 CONSUMABLES KIT
    - Hysol™ 1C Epoxy
    - Propanol/Acetone swabs
    - Loctite™ 495 Adhesive
    - Stirring Sticks
    - Syringes with Flat-tipped Needles
    - Hand Towels
    - Propanol
    - Lapping Film:
        - — Coarse grit, 12 micron
        - — Medium grit, 3 micron
        - — Fine grit, 0.5 micron
    - Bottle Spout
    - Mixing Pads
4. HFBR-0102 CUSTOM TOOLS
    - Slotted Vise
    - Polishing Weight
    - Polishing Assembly
5. USER'S MANUAL

# Specifications

| Parameter | | Value | Units |
|---|---|---|---|
| Weight | Net | 7.3 (16) | kg (lbs) |
| | Shipping | 8.2 (18) | |
| Size | Height | 356 (14) | mm (in.) |
| | Width | 457 (18) | |
| | Depth | 229 (9) | |
| Heater Wattage | Opt 100 | 600 | W |
| | Opt 2XX | 200 | |

# Ordering Guide

The HFBR-0100 Connector Assembly Tooling Kit is designed to be sold as a complete unit, ready for use. Common connectoring tools, consumables, custom tools, connector piece-parts, and the user's manual are included.

The kit is ordered by specifying both the base product number (HFBR-0100) and a heater option. The heater option specifies either a 110 VAC (option 001) or a 220 VAC (option 2XX) heater with the appropriate power cord.

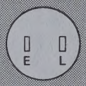
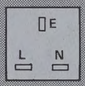
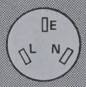
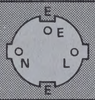
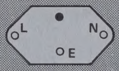
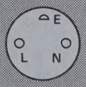
Both the Consumables Kit (HFBR-0101) and the Custom Tools (HFBR-0102) are available separately for restocking the kit. The unassembled connectors (HFBR-4000), adapters (HFBR-3099) and fiber optic cable (HFBR-3200/3300) are also available.

Order Examples:

1. Three Connector Assembly Tooling Kits — specify;
   HFBR-0100 Fiber Optic Connector Assembly Tooling Kit — Quantity 3

   Option 202: European Continent Plug, 220 VAC
2. One Consumables Kit replacement — specify;
   HFBR-0101 Consumables Kit — Quantity 1

### POWER CORD (MALE PLUG) OPTIONS

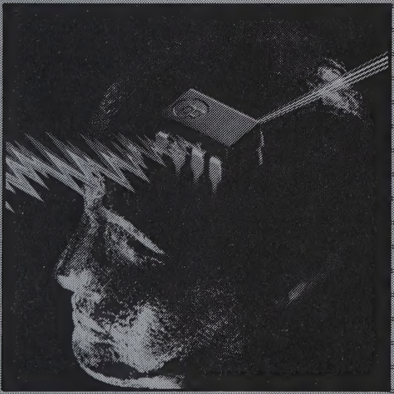
| OPTION NO. | PLUG* CONFIGURATION | COUNTRY |
|---|---|---|
| 001 |  | USA, CANADA (120V)<br>JAPAN |
| 200 |  | U.K. |
| 201 |  | AUSTRALIA, NEW ZEALAND |
| 202 |  | EUROPEAN CONTINENT |
| 206 |  | SWITZERLAND |
| 212 |  | DENMARK |

*VIEW OF PLUG FACE

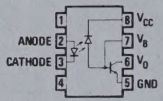
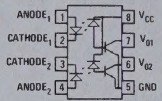
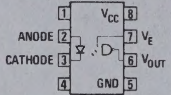
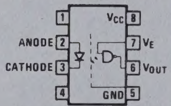
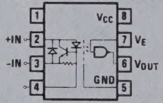
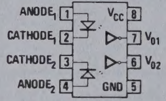
E – EARTH OR SAFETY GROUND
N – NEUTRAL OR IDENTIFIED CONDUCTOR
L – LINE OR ACTIVE CONDUCTOR

# Optocouplers

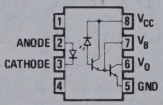
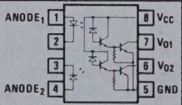
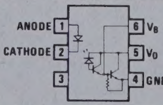
- *Selection Guide* . . . . . . . . . . . . . *330*
- *High Speed Optocouplers*
- *High Gain Optocouplers*
- *AC/DC to Logic Interface Optocoupler*
- *Hermetic Optocouplers*



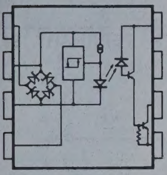
## High Speed Optocouplers

| Device | | Description | Application[1] | Typical Data Rate (NRZ) | Current Transfer Ratio | Specified Input Current | Withstand Test Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
|  1<br>8 VCC<br>ANODE 2<br>7 VB<br>CATHODE 3<br>6 VO<br>4<br>5 GND | 6N135 | Transistor Output | Line Receiver, Analog Circuits, TTL/CMOS, TTL/LSTTL Ground Isolation | 1M bit/s | 7% Min. | 16mA | 3000Vdc UL[3] | 332 |
| | 6N136 | | | | 19% Min. | | | |
| | HCPL-2502 | | | | 15-22%[2] | | | |
| | HCPL-2503 | | TTL/LSTTL Logic Interface | 250K bit/s | 12% Min. | | 3000Vdc UL[3] | 336 |
| | | | LSTTL/LSTTL Logic Interface | | 15% Min. | 8mA | | |
|  ANODE1 1<br>CATHODE1 2<br>CATHODE2 3<br>ANODE2 4<br>8 VCC<br>7 VO1<br>6 VO2<br>5 GND | HCPL-2530 | Dual Channel Transistor Output | Line Receiver, Analog Circuits, TTL/CMOS, TTL/LSTTL Ground Isolation | 1M bit/s | 7% Min. | 16mA | 3000Vdc UL[3] | 341 |
| | HCPL-2531 | | | | 19% Min. | | | |
| | HCPL-2533 | | TTL/LSTTL Logic Interface | 250K bit/s | 12% Min. | | | 345 |
| | | | LSTTL/LSTTL Logic Interface | | 15% Min. | 8mA | | |
|  1<br>VCC 8<br>ANODE 2<br>7 VE<br>CATHODE 3<br>6 VOUT<br>4<br>GND 5 | 6N137 | Optically Coupled Logic Gate | Line Receiver, High Speed Logic Ground Isolation | 10M bit/s | 700% Typ. | 5.0mA | 3000Vdc UL[3] | 350 |
|  1<br>VCC 8<br>ANODE 2<br>7 VE<br>CATHODE 3<br>6 VOUT<br>4<br>GND 5 | HCPL-2601 | High Common Mode Rejection, Optically Coupled Logic Gate | Line Receiver, High Speed Logic Ground Isolation In High Ground or Induced Noise Environments | 10M bit/s | 700% Typ. | 5.0mA | 3000Vdc UL[3] | 354 |
|  1<br>VCC 8<br>+IN 2<br>7 VE<br>-IN 3<br>6 VOUT<br>4<br>GND 5 | HCPL-2602 | Optically Coupled Line Receiver | Replace Conventional Line Receivers In High Ground or Induced Noise Environments | 10M bit/s | 700% Typ. | 5.0mA | 3000Vdc UL[3] | 358 |
|  ANODE1 1<br>CATHODE1 2<br>CATHODE2 3<br>ANODE2 4<br>VCC 8<br>7 VO1<br>6 VO2<br>GND 5 | HCPL-2630 | Dual Channel Optically Coupled Gate | Line Receiver, High Speed Logic Ground Isolation. | 10M bit/s | 700% Typ. | 5.0mA | 3000Vdc UL[3] | 364 |

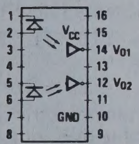
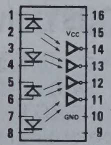
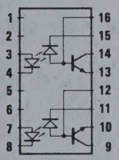
## High Gain Optocouplers

| Device | | Description | Application[1] | Typical Data Rate (NRZ) | Current Transfer Ratio | Specified Input Current | Withstand Test Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
|  1<br>8 VCC<br>ANODE 2<br>7 VB<br>CATHODE 3<br>6 VO<br>4<br>5 GND | 6N138 | Low Saturation Voltage, High Gain Output, $V_{CC}$=7VMax. | Line Receiver, Low Current Ground Isolation, TTL/TTL, LSTTL/TTL, CMOS/TTL | 300k bit/s | 300% Min. | 1.6mA | 3000Vdc UL[3] | 368 |
| | 6N139 | Low Saturation Voltage, High Gain Output, $V_{CC}$=18V Max. | Line Receiver, Ultra Low Current Ground Isolation, CMOS/LSTTL CMOS/TTL, CMOS/CMOS | | 400% Min. | 0.5mA | | |
|  ANODE1 1<br>2<br>3<br>ANODE2 4<br>8 VCC<br>7 VO1<br>6 VO2<br>5 GND | HCPL-2730 | Dual Channel, High Gain, $V_{CC}$=7V Max. | Line Receiver, Polarity Sensing, Low Current Ground Isolation | 300k bit/s | 300% Min. | 1.6mA | 3000Vdc UL[3] | 372 |
| | HCPL-2731 | Dual Channel, High Gain, $V_{CC}$=18V Max. | | | 400%Min. | 0.5mA | | |
|  ANODE 1<br>CATHODE 2<br>3<br>6 VB<br>5 VO<br>4 GND | 4N45 | Darlington Output $V_{CC}$=7V Max. | AC Isolation, Relay-Logic Isolation | 3k bit/s | 250% Min. | 1.0mA | 3000Vdc UL[3] | 374 |
| | 4N46 | Darlington Output $V_{CC}$=20V Max. | | | 350% Min. | 0.5mA | | |

# AC/DC to Logic Interface Optocoupler

| Device | | Description | Application[1] | Typical Data Rates | Input Threshold Current | Output Current | Withstand Test Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
|  | HCPL-3700 | AC/DC to Logic Threshold Sensing Interface Optocoupler | Limit Switch Sensing, Low Voltage Detector, Relay Contact Monitor | 4 KHz | 2.5mA $TH^+$<br>1.3mA $TH^-$ | 4.2mA | 3000 Vdc[3] | 380 |

# Hermetic Optocouplers

| Device | | Description | Application[1] | Typical Data Rate (NRZ) | Current Transfer Ratio | Specified Input Current | Withstand Test Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
|   1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>16<br>15<br>14 $V_{O1}$<br>13<br>12 $V_{O2}$<br>11<br>10<br>9<br>$V_{CC}$<br>GND | 6N134 | Dual Channel Hermetically Sealed Optically Coupled Logic Gate. | Line Receiver, Ground Isolation for High Reliability Systems | 10M bit/s | 400% Typ. | 10mA | 1500Vdc | 386 |
| | 6N134TXV | TXV – Screened | | | | | | |
| | 6N134TXVB | TXVB – Screened with Group B Data | | | | | | |
|   1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>16<br>15<br>14<br>13<br>12<br>11<br>10<br>9<br>Vcc<br>GND | 6N140 | Hermetically Sealed Package Containing 4 Low Input Current, High Gain Optocouplers | Line Receiver, Low Power Ground Isolation for High Reliability Systems | 300k bit/s | 300% Min. | 0.5mA | 1500Vdc | 390 |
| | 6N140TXV | TXV – Hi-Rel Screened | | | | | | |
| | 6N140TXVB | TXVB – Hi-Rel Screened with Group B Data | | | | | | |
|   1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>16<br>15<br>14<br>13<br>12<br>11<br>10<br>9 | 4N55 | Dual Channel Hermetically Sealed Analog Optical Coupler | Line Receiver, Analog Signal Ground Isolation, Switching Power Supply Feedback Element | 700k bit/s | 7% Min. | 16mA | 1500Vdc | 394 |
| | 4N55TXV | TXV – Hi-Rel Screened | | | | | | |
| | 4N55TXVB | TXVB – Hi-Rel Screened with Group B Data | | | | | | |

otes: 1. For further information, AN-939, AN-947, AN-948, AN-951-1, and AN-951-2 are available from HP free of charge. Abstracts begin on page 408.

2. The HCPL-2502 Current Transfer Ratio Specification is guaranteed to be 15% minimum and 22% maximum.

3. Recognized under the Component Recognition Program of Underwriters Laboratories Inc. (File No. E55361), 220 VAC working voltage. This is guaranteed by a 3000 Vdc withstand voltage test for 5 seconds.

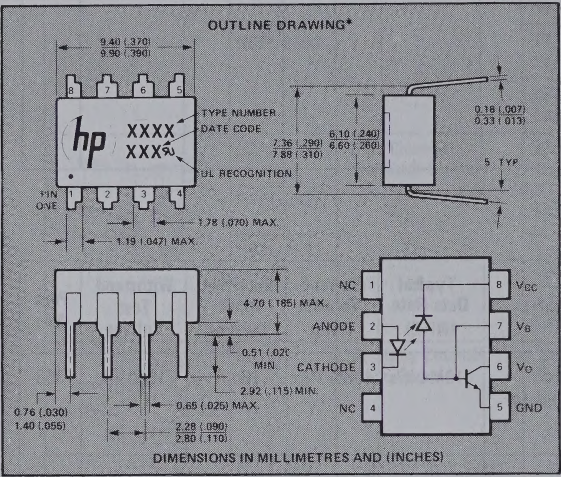
HEWLETT PACKARD

# HIGH SPEED OPTOCOUPLERS

**6N135**
**6N136**
**HCPL-2502**

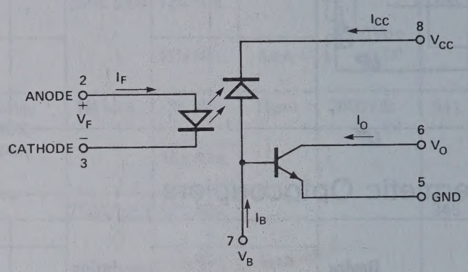
TECHNICAL DATA FEBRUARY 1982

OUTLINE DRAWING*



DIMENSIONS IN MILLIMETRES AND (INCHES)

SCHEMATIC



## Features

- **HIGH SPEED: 1 Mbit/s**
- **TTL COMPATIBLE**
- **HIGH COMMON MODE TRANSIENT IMMUNITY: 1000V/µs**
- **3000 Vdc WITHSTAND TEST VOLTAGE**
- **2 MHz BANDWIDTH**
- **OPEN COLLECTOR OUTPUT**
- **RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)**

## Description

These diode-transistor optocouplers use a light emitting diode and an integrated photon detector to provide 3000V dc electrical insulation between input and output. Separate connection for the photodiode bias and output transistor collector improve the speed up to a hundred times that of a conventional photo-transistor coupler by reducing the base-collector capacitance.

The 6N135 is suitable for use in TTL/CMOS, TTL/LSTTL or wide bandwidth analog applications. Current transfer ratio (CTR) for the 6N135 is 7% minimum at $I_F = 16$ mA.

The 6N136 is suitable for high speed TTL/TTL applications. A standard 16 mA TTL sink current through the input LED will provide enough output current for 1 TTL load and a 5.6 kΩ pull-up resistor. CTR of the 6N136 is 19% minimum at $I_F = 16$ mA.

The HCPL-2502 is suitable for use in applications where matched or known CTR is desired. CTR is 15 to 22% at $I_F = 16$ mA.

## Applications

- **Line Receivers** — High common mode transient immunity (>1000V/µs) and low input-output capacitance (0.6pF).
- **High Speed Logic Ground Isolation** — TTL/TTL, TTL/LTTL, TTL/CMOS, TTL/LSTTL.
- **Replace Slow Phototransistor Isolators** — Pins 2-7 of the 6N135/6 series conform to pins 1-6 of 6 pin phototransistor couplers. Pin 8 can be tied to any available bias voltage of 1.5V to 15V for high speed operation.
- **Replace Pulse Transformers** — Save board space and weight.
- **Analog Signal Ground Isolation** — Integrated photon detector provides improved linearity over phototransistor type.

## Absolute Maximum Ratings*

| | |
|---|---|
| Storage Temperature | −55°C to +125°C |
| Operating Temperature | −55°C to 100°C |
| Lead Solder Temperature | 260°C for 10s<br>(1.6mm below seating plane) |
| Average Input Current — $I_F$ | 25mA[1] |
| Peak Input Current — $I_F$ | 50mA[2]<br>(50% duty cycle, 1 ms pulse width) |
| Peak Transient Input Current — $I_F$ | 1.0A<br>(≤1µs pulse width, 300pps) |
| Reverse Input Voltage — $V_R$ (Pin 3-2) | 5V |
| Input Power Dissipation | 45mW[3] |
| Average Output Current — $I_O$ (Pin 6) | 8mA |
| Peak Output Current | 16mA |
| Emitter-Base Reverse Voltage (Pin 5-7) | 5V |
| Supply and Output Voltage — $V_{CC}$ (Pin 8-5), $V_O$ (Pin 6-5) | −0.5V to 15V |
| Base Current — $I_B$ (Pin 7) | 5mA |
| Output Power Dissipation | 100mW[4] |

*CAUTION: The small junction sizes inherent to the design of this bipolar component increases the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.*

**See notes, following page.**

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*JEDEC Registered Data. (The HCPL-2502 is not registered.)

# Electrical Specifications

Over recommended temperature ($T_A$ = 0°C to 70°C) unless otherwise specified.

| Parameter | Sym. | Device | Min. | Typ.** | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR* | 6N135 | 7 | 18 | | % | $I_F$ = 16mA, $V_O$ = 0.4V, $V_{CC}$ = 4.5V<br>$T_A$ = 25°C | 1,2 | 5 |
| | | 6N136 | 19 | 24 | | % | | | |
| | | HCPL-2502 | 15 | | 22 | % | | | |
| | CTR | 6N135 | 5 | 13 | | % | $I_F$ = 16mA, $V_O$ = 0.5V, $V_{CC}$ = 4.5V | | |
| | | 6N136 | 15 | 21 | | % | | | |
| Logic Low Output Voltage | $V_{OL}$ | 6N135 | | 0.1 | 0.4 | V | $I_F$ = 16mA, $I_O$ = 1.1mA, $V_{CC}$ = 4.5V | | |
| | | 6N136<br>HCPL-2502 | | 0.1 | 0.4 | V | $I_F$ = 16mA, $I_O$ = 2.4mA, $V_{CC}$ = 4.5V | | |
| Logic High Output Current | $I_{OH}$* | | | 3 | 500 | nA | $I_F$ = 0mA, $V_O$ = $V_{CC}$ = 5.5V,<br>$T_A$ = 25°C | 6 | |
| | | | | 0.01 | 1 | µA | $I_F$ = 0mA, $V_O$ = $V_{CC}$ = 15V<br>$T_A$ = 25°C | | |
| | $I_{OH}$ | | | | 50 | µA | $I_F$ = 0mA, $V_O$ = $V_{CC}$ = 15V | | |
| Logic Low Supply Current | $I_{CCL}$ | | | 40 | | µA | $I_F$ = 16mA, $V_O$ = Open, $V_{CC}$ = 15V | | |
| Logic High Supply Current | $I_{CCH}$* | | | 0.02 | 1 | µA | $I_F$ = 0mA, $V_O$ = Open, $V_{CC}$ = 15V<br>$T_A$ = 25°C | | |
| | $I_{CCH}$ | | | | 2 | µA | $I_F$ = 0mA, $V_O$ = Open, $V_{CC}$ = 15V | | |
| Input Forward Voltage | $V_F$* | | | 1.5 | 1.7 | V | $I_F$ = 16mA, $T_A$ = 25°C | 3 | |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | | | -1.6 | | mV/°C | $I_F$ = 16mA | | |
| Input Reverse Breakdown Voltage | $BV_R$* | | 5 | | | V | $I_R$ = 10µA, $T_A$ = 25°C | | |
| Input Capacitance | $C_{IN}$ | | | 60 | | pF | f = 1MHz, $V_F$ = 0 | | |
| Input-Output Insulation Leakage Current | $I_{I-O}$* | | | | 1.0 | µA | 45% Relative Humidity, t = 5s<br>$V_{I-O}$ = 3000Vdc, $T_A$ = 25°C | | 6 |
| Resistance (Input-Output) | $R_{I-O}$ | | | $10^{12}$ | | Ω | $V_{I-O}$ = 500Vdc | | 6 |
| Capacitance (Input-Output) | $C_{I-O}$ | | | 0.6 | | pF | f = 1MHz | | 6 |
| Transistor DC Current Gain | $h_{FE}$ | | | 175 | | – | $V_O$ = 5V, $I_O$ = 3mA | | |

**All typicals at $T_A$ = 25°C.

# Switching Specifications at $T_A$=25°C $V_{CC}$ = 5V, $I_F$ = 16mA, unless otherwise specified.

| Parameter | Sym. | Device | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time To Logic Low at Output | $t_{PHL}$* | 6N135 | | 0.5 | 1.5 | µs | $R_L$ = 4.1kΩ | 5,9 | 8,9 |
| | | 6N136<br>HCPL-2502 | | 0.2 | 0.8 | µs | $R_L$ = 1.9kΩ | | |
| Propagation Delay Time To Logic High at Output | $t_{PLH}$* | 6N135 | | 0.4 | 1.5 | µs | $R_L$ = 4.1kΩ | 5,9 | 8,9 |
| | | 6N136<br>HCPL-2502 | | 0.3 | 0.8 | µs | $R_L$ = 1.9kΩ | | |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ | 6N135 | | 1000 | | V/µs | $I_F$ = 0mA, $V_{CM}$ = 10Vp-p, $R_L$ = 4.1kΩ | 10 | 7,8,9 |
| | | 6N136<br>HCPL-2502 | | 1000 | | V/µs | $I_F$ = 0mA, $V_{CM}$ = $10V_{p-p}$, $R_L$ = 1.9kΩ | | |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ | 6N135 | | -1000 | | V/µs | $V_{CM}$ = $10V_{p-p}$, $R_L$ = 4.1kΩ | 10 | 7,8,9 |
| | | 6N136<br>HCPL-2502 | | -1000 | | V/µs | $V_{CM}$ = $10V_{p-p}$, $R_L$ = 1.9kΩ | | |
| Bandwidth | BW | | | 2 | | $MH_z$ | $R_L$ = 100Ω | 8 | 10 |

NOTES:

1. Derate linearly above 70°C free-air temperature at a rate of 0.8mA/°C.
2. Derate linearly above 70°C free-air temperature at a rate of 1.6mA/°C.
3. Derate linearly above 70°C free-air temperature at a rate of 0.9mW/°C.
4. Derate linearly above 70°C free-air temperature at a rate of 2.0mW/°C.
5. CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
6. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
7. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the leading edge of the common mode pulse $V_{CM}$, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM}/dt$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$).
8. The 1.9kΩ load represents 1 TTL unit load of 1.6mA and the 5.6kΩ pull-up resistor.
9. The 4.1kΩ load represents 1 LSTTL unit load of 0.36mA and 6.1kΩ pull-up resistor.
10. The frequency at which the ac output voltage is 3dB below the low frequency asymptote.

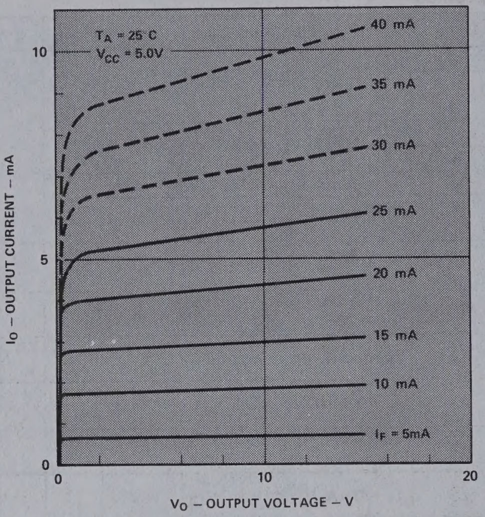


Figure 1. DC and Pulsed Transfer Characteristics.

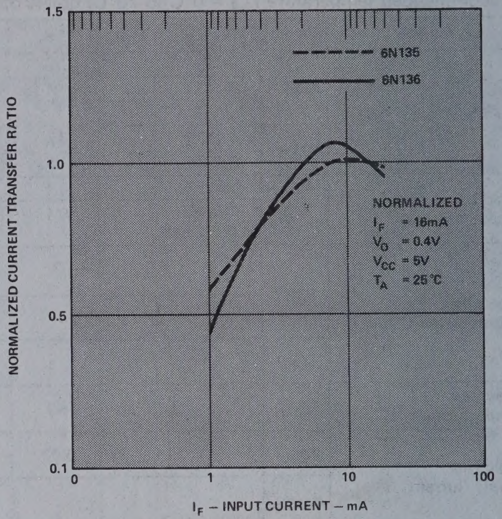


Figure 2. Current Transfer Ratio vs. Input Current.

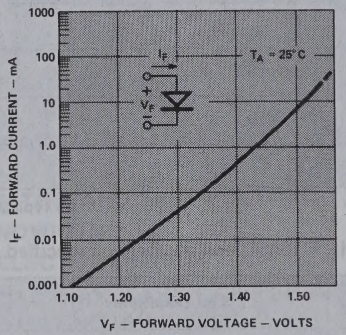


Figure 3. Input Current vs. Forward Voltage.

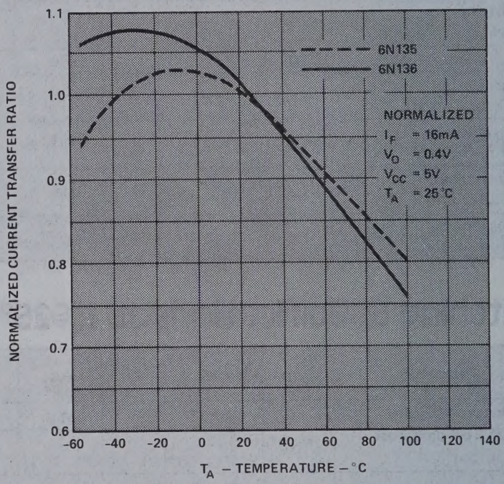


Figure 4. Current Transfer Ratio vs. Temperature.

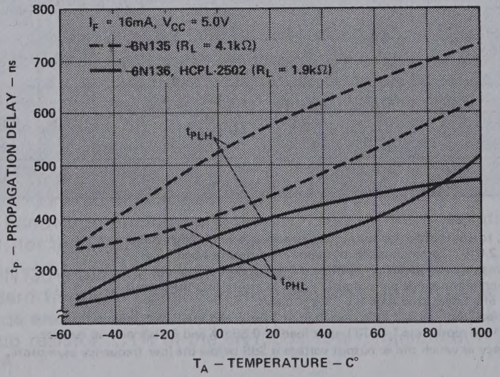


Figure 5. Propagation Delay vs. Temperature.

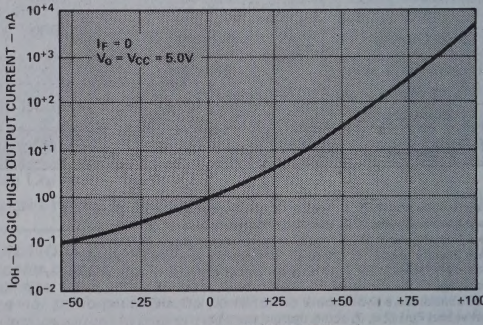


Figure 6. Logic High Output Current vs. Temperature.

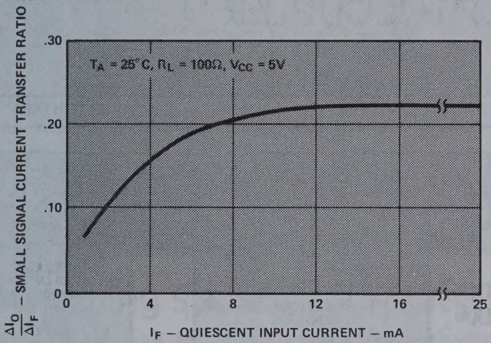


**Figure 7. Small-Signal Current Transfer Ratio vs. Quiescent Input Current.**

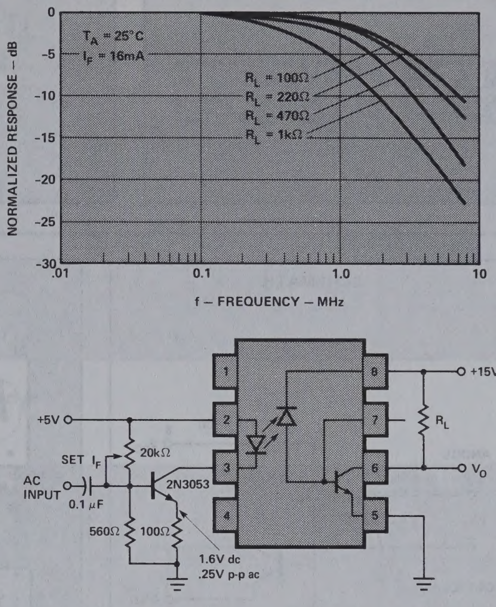


**Figure 8. Frequency Response.**

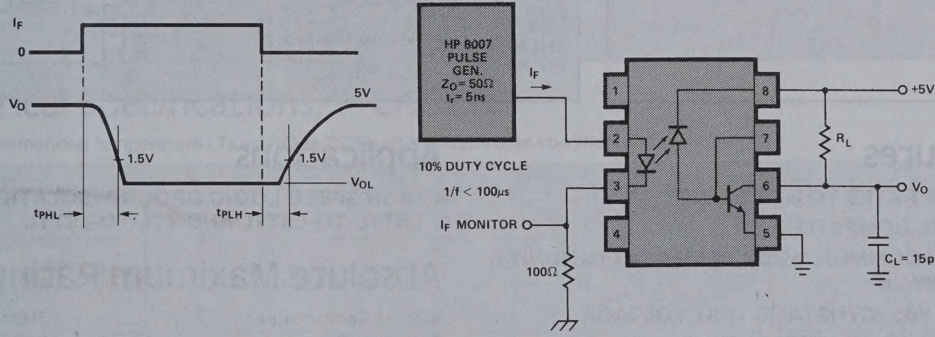
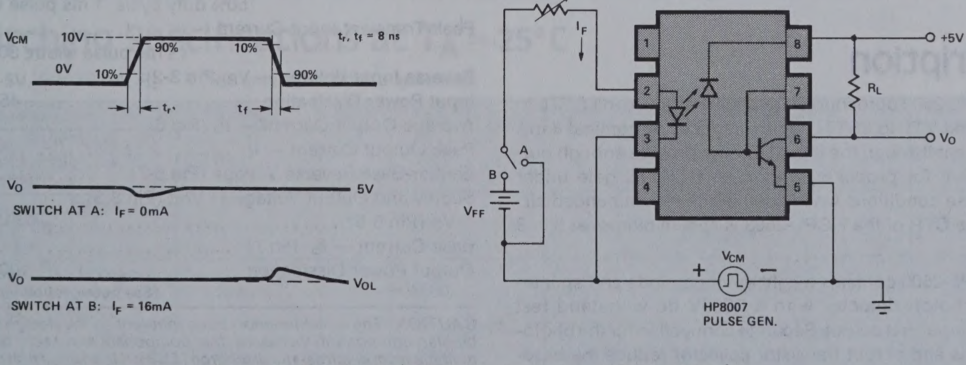

$I_F$
0
$V_O$
5V
1.5V
1.5V
$V_{OL}$
$t_{PHL}$
$t_{PLH}$
HP 8007 PULSE GEN.
$Z_O = 50\Omega$
$t_r = 5ns$
$I_F$
10% DUTY CYCLE
1/f < 100µs
$I_F$ MONITOR
100Ω
1
2
3
4
8
7
6
5
+5V
$R_L$
$V_O$
$C_L = 15pF$

**Figure 9. Switching Test Circuit.***


$V_{CM}$
10V
0V
90%
10%
10%
90%
$t_r$
$t_f$
$t_r, t_f = 8$ ns
$V_O$
5V
SWITCH AT A: $I_F = 0mA$
$V_O$
$V_{OL}$
SWITCH AT B: $I_F = 16mA$
$I_F$
A
B
$V_{FF}$
1
2
3
4
8
7
6
5
+5V
$R_L$
$V_O$
$V_{CM}$
+
–
HP8007 PULSE GEN.

*JEDEC Registered Data

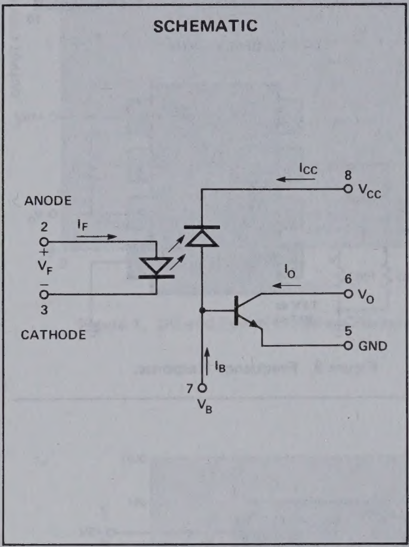
**Figure 10. Test Circuit for Transient Immunity and Typical Waveforms.**

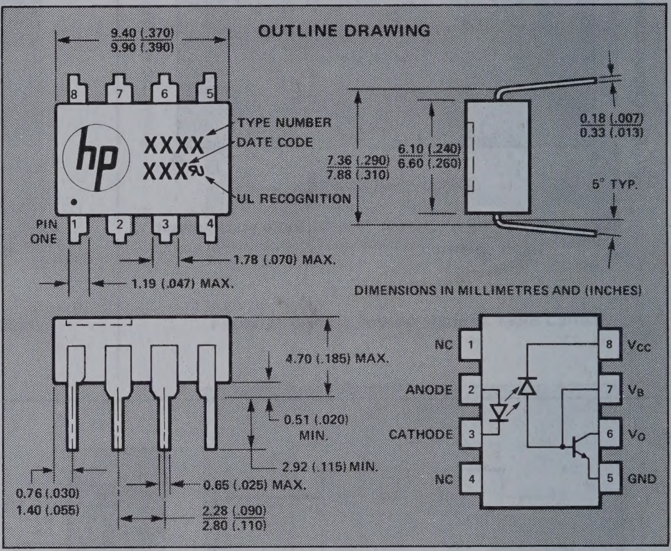
**HEWLETT PACKARD**

# LOGIC INTERFACE OPTOCOUPLER

# HCPL-2503

TECHNICAL DATA FEBRUARY 1982


SCHEMATIC
ICC
8
VCC
ANODE
2
IF
+
VF
−
3
CATHODE
IO
6
VO
5
GND
IB
7
VB


OUTLINE DRAWING
9.40 (.370)
9.90 (.390)
8 7 6 5
hp
XXXX
XXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
PIN ONE
1 2 3 4
1.78 (.070) MAX.
1.19 (.047) MAX.
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
DIMENSIONS IN MILLIMETRES AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.76 (.030)
1.40 (.055)
0.65 (.025) MAX.
2.28 (.090)
2.80 (.110)
NC 1
ANODE 2
CATHODE 3
NC 4
8 VCC
7 VB
6 VO
5 GND

## Features

- **DATA RATES TO 250K b/s NRZ**
- **LSTTL COMPATIBLE**
- **HIGH COMMON MODE TRANSIENT IMMUNITY: >1000V/μs**
- **3000 Vdc WITHSTAND TEST VOLTAGE**
- **OPEN COLLECTOR OUTPUT**
- **RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)**

## Description

The HCPL-2503 optocoupler is specified for use in LSTTL to LSTTL and TTL to LSTTL logic interfaces. A nominal 8 mA sink current through the input LED will provide enough output current for proper operation of 1 LSTTL gate under worst-case conditions when used in the recommended circuits. The CTR of the HCPL-2503 is 15% minimum at $I_F = 8$ mA.

The HCPL-2503 contains a light emitting diode and an integrated photon detector with a 3000V dc withstand test between input and output. Separate connection for the photodiode bias and output transistor collector reduce the base-collector capacitance, giving improved speed compared with conventional phototransistor couplers.

## Applications

- **HIGH SPEED LOGIC GROUND ISOLATION — LSTTL-TO-LSTTL AND TTL-TO-LSTTL**

## Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature | -55°C to +125°C |
| Operating Temperature | -55°C to +100°C |
| Lead Solder Temperature | 260°C for 10s<br>(1.6mm below seating plane) |
| Average Input Current — $I_F$ | 25mA[1] |
| Peak Input Current — $I_F$ | 50mA[2]<br>(50% duty cycle, 1 ms pulse width) |
| Peak Transient Input Current — $I_F$ | 1.0 A<br>(≤1μs pulse width, 300pps) |
| Reverse Input Voltage — $V_R$ (Pin 3-2) | 5V |
| Input Power Dissipation | 45mW[3] |
| Average Output Current — $I_O$ (Pin 6) | 8mA |
| Peak Output Current — $I_O$ | 16mA |
| Emitter-Base Reverse Voltage (Pin 5-7) | 5V |
| Supply and Output Voltage — $V_{CC}$ (Pin 8-5), $V_O$ (Pin 6-5) | -0.5V to 7V |
| Base Current — $I_B$ (Pin 7) | 5mA |
| Output Power Dissipation | 100mW[4] |

(See notes, following page.)

*CAUTION: The small junction sizes inherent to the design of this bipolar component increases the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.*

# Electrical Specifications, LSTTL/LSTTL

Over recommended temperature ($T_A$ = 0° C to 70° C) unless otherwise specified.

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR | 15 | 22 |  | % | $I_F$ = 8mA, $V_O$ = 0.5V, $V_{CC}$ = 4.5V<br>$T_A$ = 25° C | 1 | 5 |
|  |  | 11 | 15 |  | % | $I_F$ = 8mA, $V_O$ = 0.5V, $V_{CC}$ = 4.5V |  |  |
| Logic Low Output Voltage | $V_{OL}$ |  | 0.2 | 0.5 | V | $I_F$ = 8mA, $I_O$ = 0.7mA,<br>$V_{CC}$ = 4.5V |  |  |
| Logic Low Supply Current | $I_{CCL}$ |  | 20 |  | μA | $I_F$ = 8mA<br>$V_O$ = Open, $V_{CC}$ = 5.5V |  |  |
| Input Forward Voltage | $V_F$ |  | 1.5 | 1.7 | V | $I_F$ = 8mA, $T_A$ = 25° C | 2 |  |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ |  | -1.6 |  | mV/° C | $I_F$ = 8mA |  |  |

# Switching Specifications at $T_A$ = 25° C

$V_{CC}$ = 5V, $I_F$ = 8mA, $R_L$ = 7.5kΩ unless otherwise specified.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to Logic Low at Output | $t_{PHL}$ |  | 1.0 | 1.5 | μs |  | 4,6 | 8 |
| Propagation Delay Time to Logic High at Output | $t_{PLH}$ |  | 1.5 | 2.5 | μs |  | 4,6 | 8 |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ |  | 1000 |  | V/μs | $I_F$ = 0mA, $V_{CM}$ = 10$V_{p-p}$ | 7 | 7,8 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ |  | -1000 |  | V/μs | $V_{CM}$ = 10$V_{p-p}$ | 7 | 7,8 |

# Electrical Specifications, TTL/LSTTL

Over recommended temperature ($T_A$ = 0° C to 70° C) unless otherwise specified.

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR | 12 | 18 |  | % | $I_F$ = 16mA, $V_O$ = 0.5V,<br>$V_{CC}$ = 4.5V, $T_A$ = 25° C | 1 | 5 |
|  |  | 9 | 13 |  | % | $I_F$ = 16mA, $V_O$ = 0.5V,<br>$V_{CC}$ = 4.5V |  |  |
| Logic Low Output Voltage | $V_{OL}$ |  | 0.2 | 0.5 | V | $I_F$ = 16mA, $I_O$ = 1.1mA,<br>$V_{CC}$ = 4.5V |  |  |
| Logic Low Supply Current | $I_{CCL}$ |  | 40 |  | μA | $I_F$ = 16mA<br>$V_O$ = Open, $V_{CC}$ = 5.5V |  |  |
| Input Forward Voltage | $V_F$ |  | 1.5 | 1.7 | V | $I_F$ = 16mA, $T_A$ = 25° C | 2 |  |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ |  | -1.6 |  | mV/° C | $I_F$ = 16mA |  |  |

# Switching Specifications at $T_A$ = 25° C

$V_{CC}$ = 5V, $I_F$ = 16mA, $R_L$ = 4.7kΩ unless otherwise specified.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to Logic Low at Output | $t_{PHL}$ |  | 0.4 | 1.5 | μs |  | 4,6 | 9 |
| Propagation Delay Time to Logic High at Output | $t_{PLH}$ |  | 1.5 | 2.5 | μs |  | 4,6 | 9 |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ |  | 1000 |  | V/μs | $I_F$ = 0mA, $V_{CM}$ = 10$V_{p-p}$ | 7 | 7,9 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ |  | -1000 |  | V/μs | $V_{CM}$ = 10$V_{p-p}$ | 7 | 7,9 |

*All typicals at 25° C.

(See following page for notes.)

# Electrical Specifications

Over recommended temperature ($T_A = 0°C$ to $70°C$) unless otherwise specified.

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Logic High Output Current | $I_{OH}$ | | 0.5 | | nA | $T_A = 25°C$, $I_F = 0$ mA<br>$V_O = V_{CC} = 5.5V$ | 5 | |
| | | | | 50 | µA | $I_F = 0$ mA<br>$V_O = V_{CC} = 5.5V$ | | |
| Logic High Supply Current | $I_{CCH}$ | | 0.05 | 4 | µA | $I_F = 0$ mA<br>$V_O$ = Open, $V_{CC} = 5.5V$ | | |
| Input Reverse Breakdown Voltage | $V_R$ | 5 | | | V | $I_F = 10$ µA, $T_A = 25°C$ | | |
| Input Capacitance | $C_{IN}$ | | 60 | | pF | f = 1 MHz, $V_F = 0V$ | | |
| Input-Output Insulation Leakage Current | $I_{I-O}$ | | | 1.0 | µA | 45% Relative Humidity, t = 5s<br>$V_{I-O} = 3000V$ dc, $T_A = 25°C$ | | 6 |
| Resistance (Input-Output) | $R_{I-O}$ | | $10^{12}$ | | Ω | $V_{I-O} = 500V$ dc | | 6 |
| Capacitance (Input-Output) | $C_{I-O}$ | | 0.6 | | pF | f = 1 MHz | | 6 |

**Notes:**

1. Derate linearly above 70° C free-air temperature at a rate of 0.8mA/° C.
2. Derate linearly above 70° C free-air temperature at a rate of 1.6mA/° C.
3. Derate linearly above 70° C free-air temperature at a rate of 0.9mW/° C.
4. Derate linearly above 70° C free-air temperature at a rate of 2.0mW/° C.
5. CURRENT TRANSFER RATIO is defined as the ratio of output collector current, I/O, to the forward LED input current, $I_F$, times 100%.
6. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
7. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the leading edge of the common mode pulse $V_{CM}$, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM}/dt$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$).
8. The 7.5k load represents 1 LSTTL until load of 0.36mA and a 20kΩ pull-up resistor.
9. The 4.7k load represents 1 LSTTL unit load of 0.36mA and an 8.2kΩ pull-up resistor.

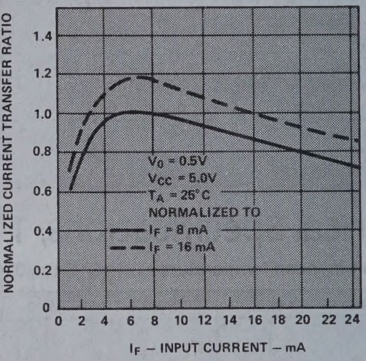


**Figure 1. Current Transfer Ratio vs. Input Current**

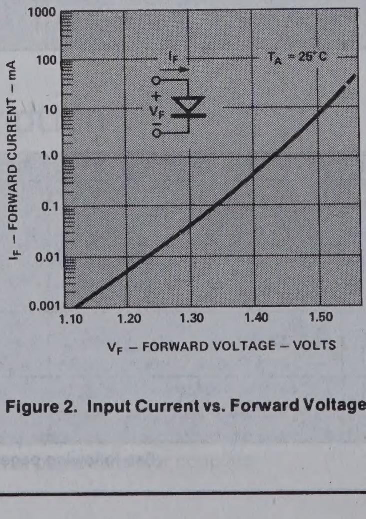


**Figure 2. Input Current vs. Forward Voltage**

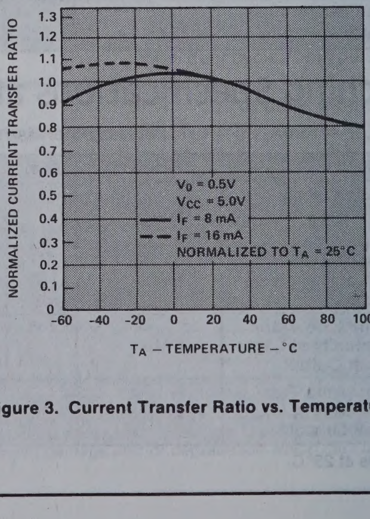


**Figure 3. Current Transfer Ratio vs. Temperature**

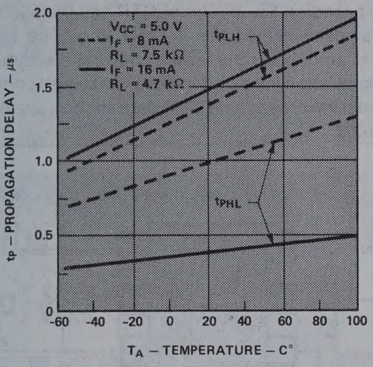


Figure 4. Propagation Delay vs. Temperature

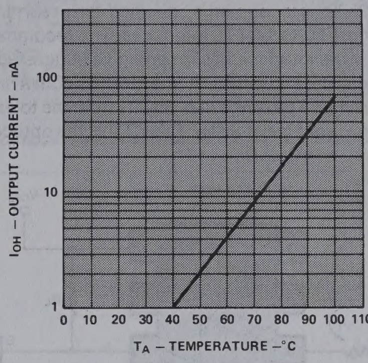


Figure 5. Logic High Output Current vs. Temperature

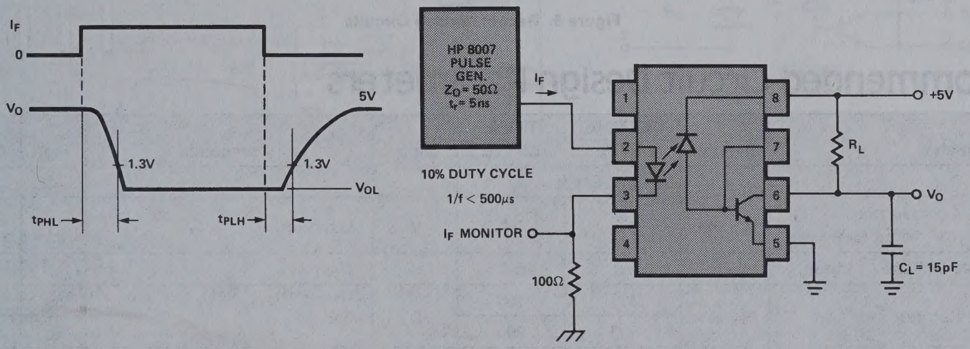

IF
0
VO
5V
1.3V
1.3V
VOL
tPHL
tPLH
HP 8007
PULSE
GEN.
ZO = 50Ω
tr = 5ns
10% DUTY CYCLE
1/f < 500µs
IF
IF MONITOR
100Ω
1
2
3
4
8
7
6
5
+5V
RL
VO
CL = 15pF

Figure 6. Switching Test Circuit

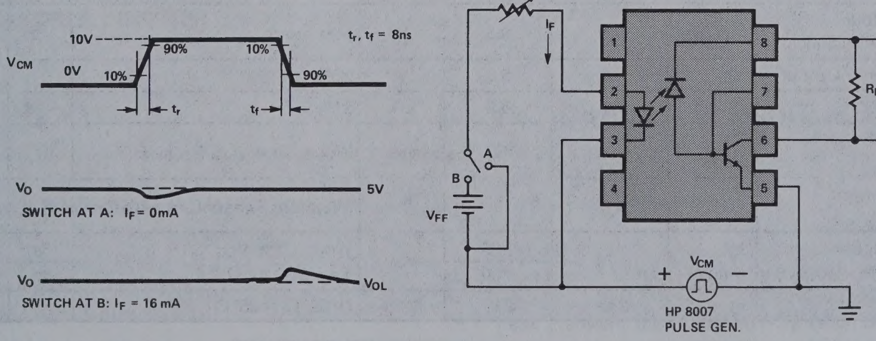
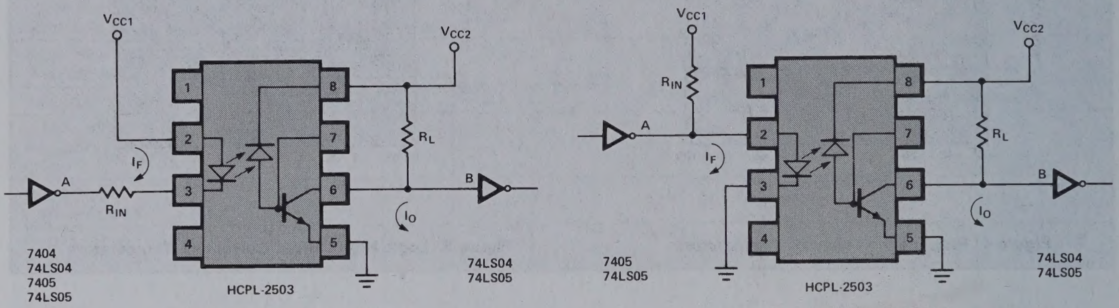

10V
VCM
0V
10%
90%
10%
90%
tr
tf
tr, tf = 8ns
VO
5V
SWITCH AT A: IF = 0mA
VO
VOL
SWITCH AT B: IF = 16 mA
IF
A
B
VFF
1
2
3
4
8
7
6
5
+5V
RL
VO
VCM
+
–
HP 8007
PULSE GEN.

Figure 7. Test Circuit for Transient Immunity and Typical Waveforms

## Recommended Operation

The HCPL-2503 optocoupler is specified for use in LSTTL-to-LSTTL and TTL-to-LSTTL interfaces. The recommended circuits show the interface design and give suggested component values. The input current $I_F$ is given as both a nominal value and a range. The range in $I_F$ results from the tolerances in $V_{CC}$ and the input resistor $R_{IN}$. The CTR of the optocoupler is given as the minimum initial value over temperature, taken directly from the Electrical Specifications. The value given for $I_{OL}(min)$ is based on the minimum CTR and the minimum $I_F$ using worst case values for $R_L$ and $V_{CC}$. The resulting $I_{OL}(min)$ has ample design margin, allowing more than 20% for CTR degradation even under these worst case conditions. For additional information on CTR degradation see Application Note 1002.



a. TYPICAL NON-INVERTING CIRCUIT

b. TYPICAL INVERTING CIRCUIT (SEE NOTE 10)

Figure 8. Recommended Circuits

## Recommended Circuit Design Parameters

| Parameter | Symbol | LSTTL to LSTTL | TTL to LSTTL | Units | Comments | Fig. | Note |
|---|---|---|---|---|---|---|---|
| **INPUT** | | | | | | | |
| Logic Low Output Voltage — Input Gate | $V_{OL}(A)$ | 0.5 | 0.4 | V | Maximum | | |
| Supply Voltage — Input | $V_{CC1}$ | 5.0 | 5.0 | V | ±5% | | |
| Input Resistor | $R_{IN}$ | 360<br>430 | 180<br>200 | Ω | ±5% | 8a<br>8b | |
| Input Current | $I_F$ | 8 | 16 | mA | Nominal | | |
| Input Current Range | $I_F$ | 6.75—10 | 14.0—20<br>14.5—20 | mA | | 8a<br>8b | |
| **OUTPUT** | | | | | | | |
| Logic Low Output Voltage — HCPL-2503 | $V_{OL}(B)$ | 0.5 | 0.5 | V | Maximum | | |
| Supply Voltage — Output | $V_{CC2}$ | 5.0 | 5.0 | V | ±5% | | |
| Pull-Up Resistor | $R_L$ | 20 | 8.2 | kΩ | ±5% | | 11 |
| Required Current Sink for Logic Low | $I_{OL}$ (max) | 0.61 | 1.0 | mA | Worst Case $V_{CC}$, $R_L$, $I_{IL}(B)$ | | 12 |
| HCPL-2503 Current Transfer Ratio | CTR | 11 | 9 | % | Minimum $T_A = 0°C$ to $+70°C$ | | |
| Logic Low Output Current — HCPL-2503 | $I_{OL}$ (min) | 0.74 | 1.26<br>1.30 | mA | Worst Case $V_{CC}$, CTR, $I_F$<br>$T_A = 0°C$ to $+70°C$ | 8a<br>8b | 13 |
| Data Rate | $f_D$ | 250 | 250 | Kb/s | NRZ, $T_A = 25°C$ | | 14 |

**Notes:**

10. The inverting circuit has higher power consumption and must use open collector gates on the input.
11. The load resistor $R_L$ must be large enough to guarantee logic LOW and small enough to guarantee logic HIGH under worst case conditions:

$$\frac{V_{CC}(max) - V_{OL}}{I_{OL}(2503) - I_{IL}(B)} \leq R_L \leq \frac{V_{CC}(min) - V_{IH}(B)}{I_{OH}(2503) - I_{IH}(B)}$$

The selection of $R_L$ is the same for both inverting and non-inverting circuits.

12. The maximum current sink required for logic LOW is:

$$I_{OL}(max) = I_{IL}(B)(max) + I_R(max)$$

where $I_R$ is the current through $R_L$.

13. The ratio of $I_{OL}(min)$ to $I_{OL}(max)$ gives the design margin for CTR degradation. See Application Note 1002.
14. The maximum data rate is defined as

$$f_D = \frac{1}{t_{PHL} + t_{PLH}} \text{ bits/second NRZ}$$

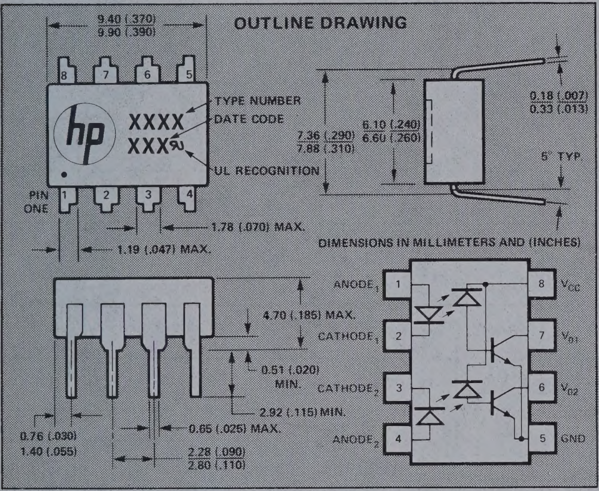
HEWLETT PACKARD

# DUAL HIGH SPEED OPTOCOUPLER

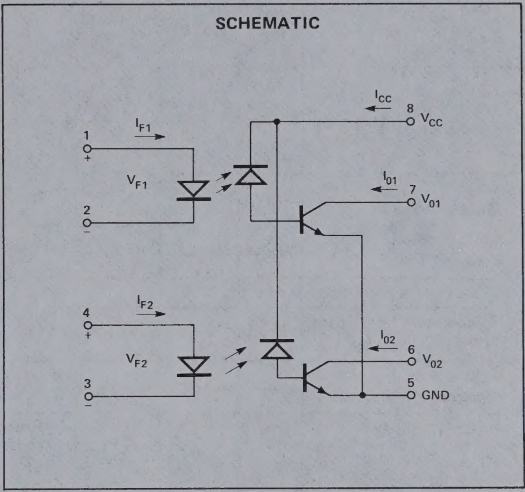
# HCPL-2530
# HCPL-2531

TECHNICAL DATA FEBRUARY 1982

OUTLINE DRAWING


9.40 (.370)
9.90 (.390)
8
7
6
5
hp
XXXX
XXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
PIN ONE
1
2
3
4
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
1.78 (.070) MAX.
1.19 (.047) MAX.
DIMENSIONS IN MILLIMETERS AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
ANODE1
CATHODE1
CATHODE2
ANODE2
VCC
VO1
VO2
GND

SCHEMATIC


ICC
8
VCC
IF1
1
+
VF1
2
−
IO1
7
VO1
IF2
4
+
VF2
3
−
IO2
6
VO2
5
GND

## Features

- **HIGH SPEED: 1 Mbit/s**
- **TTL COMPATIBLE**
- **HIGH COMMON MODE TRANSIENT IMMUNITY: >1000V/µs**
- **HIGH DENSITY PACKAGING**
- **3000 Vdc WITHSTAND TEST VOLTAGE**
- **3 MHz BANDWIDTH**
- **OPEN COLLECTOR OUTPUTS**
- **RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)**

## Description

The HCPL-2530/31 dual couplers contain a pair of light emitting diodes and integrated photon detectors with 3000V dc electrical insulation between input and output. Separate connection for the photodiode bias and output transistor collectors improve the speed up to a hundred times that of a conventional phototransistor coupler by reducing the base-collector capacitance.

The HCPL-2530 is suitable for use in TTL/CMOS, TTL/LSTTL or wide bandwidth analog applications. Current transfer ratio (CTR) for the -2530 is 7% minimum at $I_F$ = 16 mA.

The HCPL-2531 is suitable for high speed TTL/TTL applications. A standard 16 mA TTL sink current through the input LED will provide enough output current for 1 TTL load and a 5.6kΩ pull-up resistor. CTR of the -2531 is 19% minimum at $I_F$ = 16 mA.

## Applications

- **Line Receivers** — High common mode transient immunity (>1000V/µs) and low input-output capacitance (0.6pF).
- **High Speed Logic Ground Isolation** — TTL/TTL, TTL/LTTL, TTL/CMOS, TTL/LSTTL.
- **Replace Pulse Transformers** — Save board space and weight.
- **Analog Signal Ground Isolation** — Integrated photon detector provides improved linearity over phototransistor type.
- **Polarity Sensing.**
- **Isolated Analog Amplifier** — Dual channel packaging enhances thermal tracking.

## Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature . . . . . . . . . . . . . . . | -55°C to +125°C |
| Operating Temperature . . . . . . . . . . . . . . | -55°C to +100°C |
| Lead Solder Temperature . . . . . . . . . . . . . . | 260°C for 10s (1.6mm below seating plane) |
| Average Input Current — $I_F$ (each channel) . . . . . . | 25mA[1] |
| Peak Input Current — $I_F$ (each channel) . . . . . . . . . | 50mA[2] (50% duty cycle, 1 ms pulse width) |
| Peak Transient Input Current — $I_F$ (each channel) . . . . | 1.0 A (≤1µs pulse width, 300pps) |
| Reverse Input Voltage — $V_R$ (each channel) . . . . . . . . . . | 5V |
| Input Power Dissipation (each channel) . . . . . . . | 45mW[3] |
| Average Output Current — $I_O$ (each channel) . . . . . . . | 8mA |
| Peak Output Current — $I_O$ (each channel) . . . . . . . . . . | 16mA |
| Supply and Output Voltage — $V_{CC}$ (Pin 8-5), $V_O$ (Pin 7,6-5) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | -0.5V to 15V |
| Output Power Dissipation (each channel) . . . . . . | 35mW[4] |

See notes, following page.

## Electrical Specifications

Over recommended temperature ($T_A$ = 0°C to 70°C) unless otherwise specified.

| Parameter | Sym. | Device HCPL- | Min. | Typ.** | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR | 2530 | 7 | 18 | | % | $I_F$ = 16mA, $V_O$ = 0.5V, $V_{CC}$ = 4.5V<br>$T_A$ = 25°C | 1,2 | 5,6 |
| | | 2531 | 19 | 24 | | % | | | |
| | | 2530 | 5 | 13 | | % | $I_F$ = 16mA, $V_O$ = 0.5V, $V_{CC}$ = 4.5V | | |
| | | 2531 | 15 | 21 | | % | | | |
| Logic Low Output Voltage | $V_{OL}$ | 2530 | | 0.1 | 0.5 | V | $I_F$ = 16mA, $I_O$ = 1.1mA, $V_{CC}$ = 4.5V,<br>$T_A$ = 25°C | | 5 |
| | | 2531 | | 0.1 | 0.5 | V | $I_F$ = 16mA, $I_O$ = 2.4mA, $V_{CC}$ = 4.5V,<br>$T_A$ = 25°C | | |
| Logic High Output Current | $I_{OH}$ | | | 3 | 500 | nA | $T_A$ = 25°C, $I_{F1}$ = $I_{F2}$ = 0,<br>$V_{O1}$ = $V_{O2}$ = $V_{CC}$ = 5.5V | 6 | 5 |
| | | | | | 50 | µA | $I_{F1}$ = $I_{F2}$ = 0,<br>$V_{O1}$ = $V_{O2}$ = $V_{CC}$ = 15V | | 5 |
| Logic Low Supply Current | $I_{CCL}$ | | | 80 | | µA | $I_{F1}$ = $I_{F2}$ = 16mA<br>$V_{O1}$ = $V_{O2}$ = Open, $V_{CC}$ = 15V | | |
| Logic High Supply Current | $I_{CCH}$ | | | 0.05 | 4 | µA | $I_{F1}$ = $I_{F2}$ = 0mA<br>$V_{O1}$ = $V_{O2}$ = Open, $V_{CC}$ = 15V | | |
| Input Forward Voltage | $V_F$ | | | 1.5 | 1.7 | V | $I_F$ = 16mA, $T_A$ = 25°C | 3 | 5 |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | | | -1.6 | | mV/°C | $I_F$ = 16mA | | 5 |
| Input Reverse Breakdown Voltage | $V_R$ | | 5 | | | V | $I_F$ = 10µA, $T_A$ = 25°C | | 5 |
| Input Capacitance | $C_{IN}$ | | | 60 | | pF | f = 1MHz, $V_F$ = 0 | | 5 |
| Input - Output Insulation Leakage Current | $I_{I-O}$ | | | | 1.0 | µA | 45% Relative Humidity, t = 5 s<br>$V_{I-O}$ = 3000Vdc, $T_A$ = 25°C | | 7 |
| Resistance (Input-Output) | $R_{I-O}$ | | | $10^{12}$ | | Ω | $V_{I-O}$ = 500Vdc | | 7 |
| Capacitance (Input-Output) | $C_{I-O}$ | | | 0.6 | | pF | f = 1MHz | | 7 |
| Input-Input Insulation Leakage Current | $I_{I-I}$ | | | 0.005 | | µA | 45% Relative Humidity, t = 5 s<br>$V_{I-I}$ = 500Vdc | | 8 |
| Resistance (Input-Input) | $R_{I-I}$ | | | $10^{11}$ | | Ω | $V_{I-I}$ = 500Vdc | | 8 |
| Capacitance (Input-Input) | $C_{I-I}$ | | | 0.25 | | pF | f = 1MHz | | 8 |

**All typicals at 25°C.

## Switching Specifications at $T_A$=25°C $V_{CC}$ = 5V, $I_F$ = 16mA, unless otherwise specified

| Parameter | Sym. | Device HCPL- | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time To Logic Low at Output | $t_{PHL}$ | 2530 | | 0.3 | 1.5 | µs | $R_L$ = 4.1kΩ | 5,9 | 10,11 |
| | | 2531 | | 0.2 | 0.8 | µs | $R_L$ = 1.9kΩ | | |
| Propagation Delay Time to Logic High at Output | $t_{PLH}$ | 2530 | | 0.4 | 1.5 | µs | $R_L$ = 4.1kΩ | 5,9 | 10,11 |
| | | 2531 | | 0.3 | 0.8 | µs | $R_L$ = 1.9kΩ | | |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ | 2530 | | 1000 | | V/µs | $I_F$ =0mA, $R_L$ =4.1kΩ, $V_{CM}$=10$V_{p-p}$ | 10 | 9,10,11 |
| | | 2531 | | 1000 | | V/µs | $I_F$=0mA, $R_L$=1.9kΩ, $V_{CM}$=10$V_{p-p}$ | | |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ | 2530 | | -1000 | | V/µs | $V_{CM}$=10$V_{p-p}$, $R_L$ = 4.1kΩ | 10 | 9,10,11 |
| | | 2531 | | -1000 | | V/µs | $V_{CM}$ = 10$V_{p-p}$, $R_L$ = 1.9kΩ | | |
| Bandwidth | BW | | | 3 | | MHz | $R_L$ = 100Ω | 8 | 12 |

NOTES:

1. Derate linearly above 70°C free-air temperature at a rate of 0.8mA/°C.
2. Derate linearly above 70°C free-air temperature at a rate of 1.6mA/°C.
3. Derate linearly above 70°C free-air temperature at a rate of 0.9mW/°C.
4. Derate linearly above 70°C free-air temperature at a rate of 1.0mW/°C.
5. Each channel.
6. CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
7. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
8. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
9. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the leading edge of the common mode pulse $V_{CM}$, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM}/dt$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$).
10. The 1.9kΩ load represents 1 TTL unit load of 1.6mA and the 5.6kΩ pull-up resistor.
11. The 4.1kΩ load represents 1 LSTTL unit load of 0.36mA and 6.1kΩ pull-up resistor.
12. The frequency at which the ac output voltage is 3dB below the low frequency asymptote.

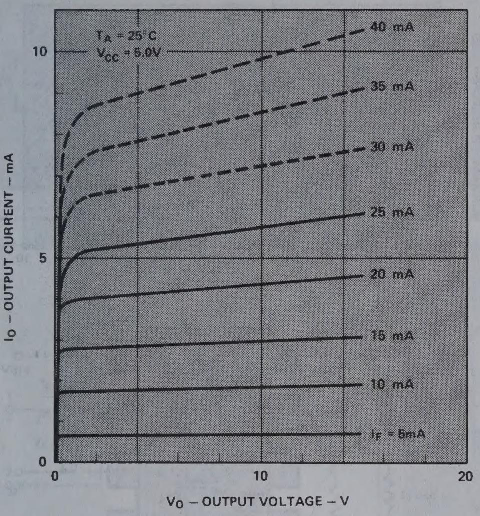


**Figure 1. DC and Pulsed Transfer Characteristics.**

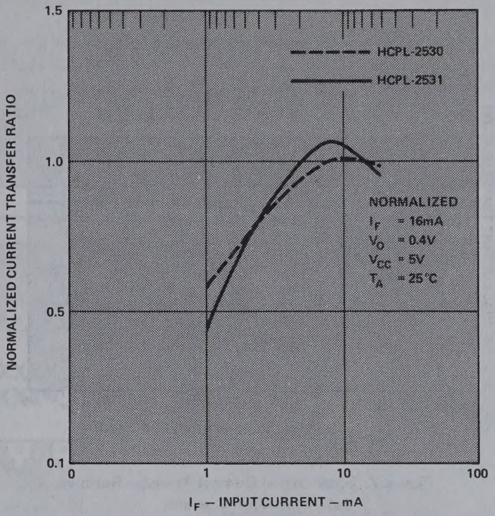


**Figure 2. Current Transfer Ratio vs. Input Current.**

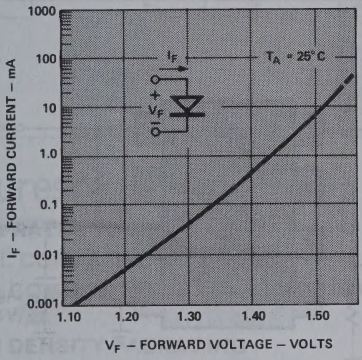


**Figure 3. Input Current vs. Forward Voltage.**

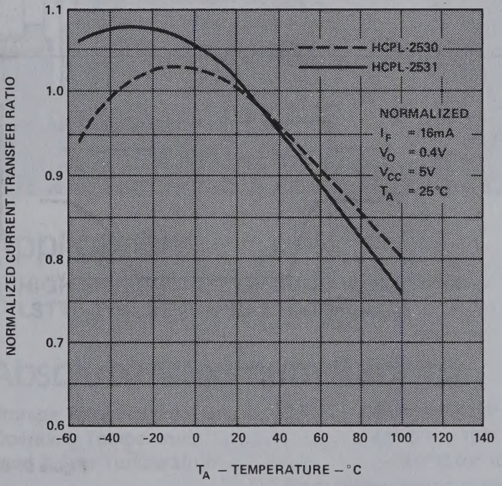


**Figure 4. Current Transfer Ratio vs. Temperature.**

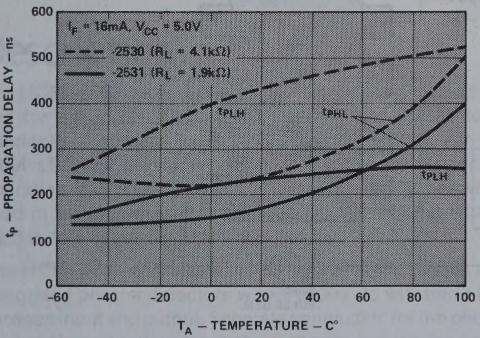


**Figure 5. Propagation Delay vs. Temperature.**

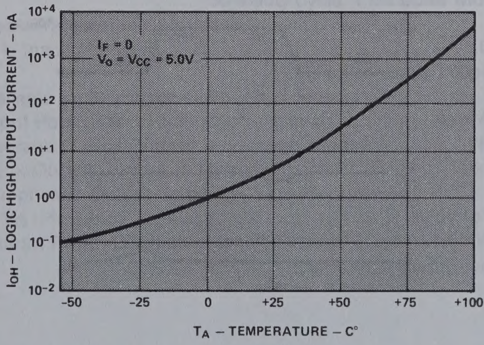


**Figure 6. Logic High Output Current vs. Temperature.**

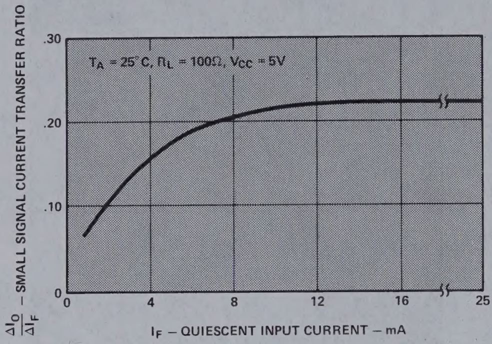


Figure 7. Small-Signal Current Transfer Ratio vs. Quiescent Input Current.

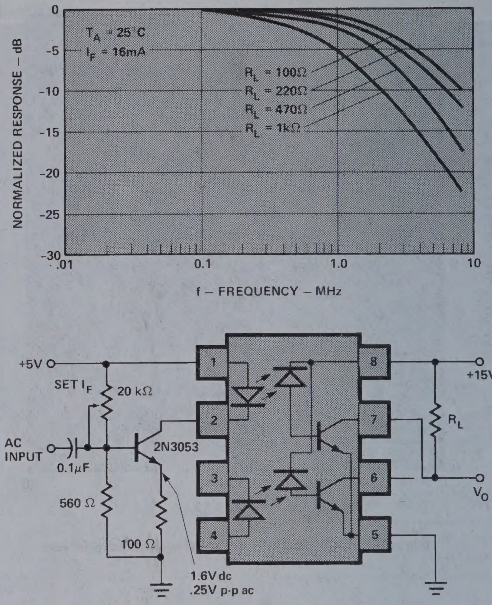


Figure 8. Frequency Response.

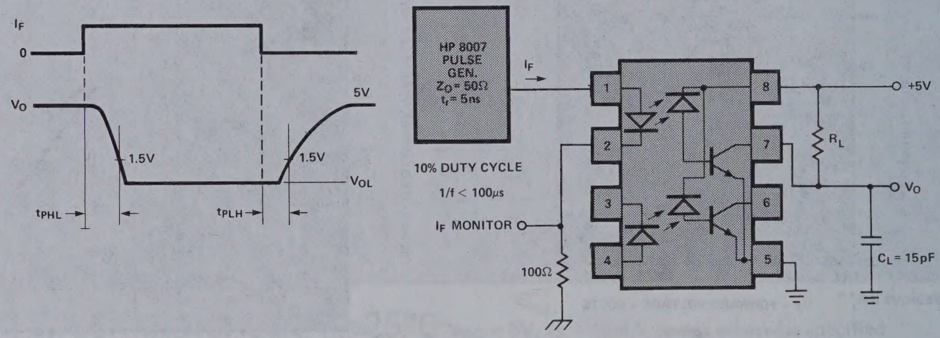

$I_F$
0
$V_O$
5V
1.5V
1.5V
$V_{OL}$
$t_{PHL}$
$t_{PLH}$
HP 8007 PULSE GEN.
$Z_O = 50\Omega$
$t_r = 5ns$
$I_F$
10% DUTY CYCLE
1/f < 100µs
$I_F$ MONITOR
100Ω
1
2
3
4
8
7
6
5
+5V
$R_L$
$V_O$
$C_L = 15pF$

Figure 9. Switching Test Circuit.

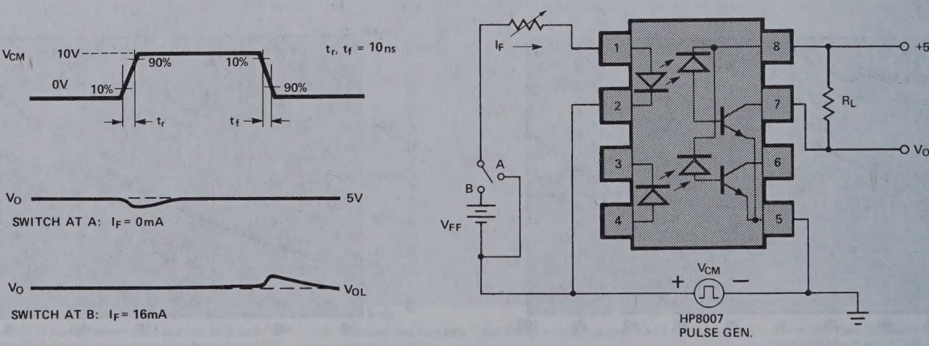

$V_{CM}$
10V
0V
90%
10%
10%
90%
$t_r, t_f = 10ns$
$t_r$
$t_f$
$V_O$
5V
SWITCH AT A: $I_F = 0mA$
$V_O$
$V_{OL}$
SWITCH AT B: $I_F = 16mA$
$I_F$
A
B
$V_{FF}$
1
2
3
4
8
7
6
5
+5V
$R_L$
$V_O$
$V_{CM}$
+
–
HP8007 PULSE GEN.

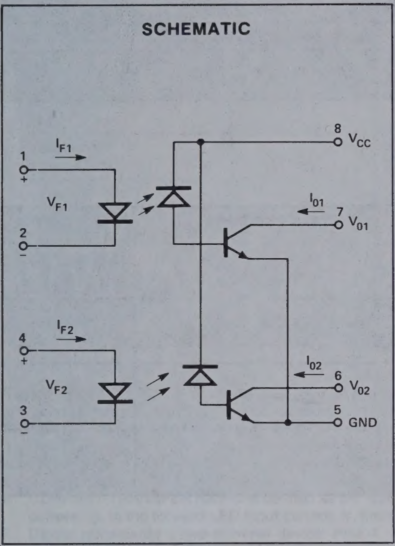
Figure 10. Test Circuit for Transient Immunity and Typical Waveforms.

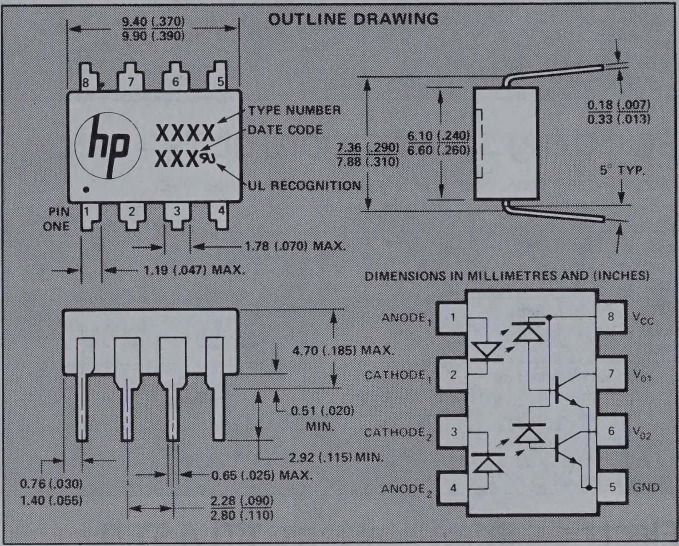
**HEWLETT PACKARD**

# DUAL LOGIC INTERFACE OPTOCOUPLER

# HCPL-2533

TECHNICAL DATA FEBRUARY 1982


SCHEMATIC
1
+
$I_{F1}$
$V_{F1}$
2
−
8
$V_{CC}$
$I_{01}$
7
$V_{01}$
4
+
$I_{F2}$
$V_{F2}$
3
−
$I_{02}$
6
$V_{02}$
5
GND


OUTLINE DRAWING
9.40 (.370)
9.90 (.390)
8 7 6 5
hp
XXXX
XXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
PIN ONE
1 2 3 4
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
1.78 (.070) MAX.
1.19 (.047) MAX.
DIMENSIONS IN MILLIMETRES AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
ANODE₁ 1
CATHODE₁ 2
CATHODE₂ 3
ANODE₂ 4
8 $V_{CC}$
7 $V_{01}$
6 $V_{02}$
5 GND

## Features

- **DATA RATES TO 250k b/s NRZ**
- **LSTTL COMPATIBLE**
- **HIGH COMMON MODE TRANSIENT IMMUNITY: >1000V/μs**
- **HIGH DENSITY PACKAGING**
- **3000 Vdc WITHSTAND TEST VOLTAGE**
- **OPEN COLLECTION OUTPUTS**
- **RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)**

## Description

The HCPL-2533 is a dual channel optocoupler which is specified for use in LSTTL to LSTTL and TTL to LSTTL logic interfaces. A nominal 8 mA LSTTL sink current through the input LED will provide enough output current for proper operation of 1 LSTTL gate under worst-case conditions when used in the recommended circuits. The CTR of the HCPL-2533 is 15% minimum at $I_F = 8$ mA.

The HCPL-2533 contains a pair of light emitting diodes and integrated photon detectors with a 3000V dc withstand test between input and output. Separate connection for the photodiode bias and output transistor collector reduce the base-collector capacitance, giving improved speed compared with conventional phototransistor couplers.

## Applications

- **HIGH SPEED LOGIC GROUND ISOLATION — LSTTL-TO-LSTTL AND TTL-TO-LSTTL**

## Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature | -55° C to +125° C |
| Operating Temperature | -55° C to +100° C |
| Lead Solder Temperature | 260° C for 10s<br>(1.6mm below seating plane) |
| Average Input Current — $I_F$ (each channel) | 25mA[1] |
| Peak Input Current — $I_F$ (each channel) | 50mA[2]<br>(50% duty cycle, 1 ms pulse width) |
| Peak Transient Input Current — $I_F$ (each channel) | 1.0 A<br>(≤1μs pulse width, 300pps) |
| Reverse Input Voltage — $V_R$ (each channel) | 5V |
| Input Power Dissipation (each channel) | 45mW[3] |
| Average Output Current — $I_O$ (each channel) | 8mA |
| Peak Output Current — $I_O$ (each channel) | 16mA |
| Supply and Output Voltage — $V_{CC}$ (Pin 8-5), $V_O$ (Pin 7,6-5) | -0.5V to 7V |
| Output Power Dissipation (each channel) | 35mW[4] |

(See notes, following page.)

# Electrical Specifications, LSTTL/LSTTL

Over recommended temperature ($T_A = 0°C$ to $70°C$) unless otherwise specified.

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR | 15 | 22 | | % | $I_F = 8mA$, $V_O = 0.5V$, $V_{CC} = 4.5V$ $T_A = 25°C$ | 1 | 5,6 |
| | | 11 | 15 | | % | $I_F = 8mA$, $V_O = 0.5V$, $V_{CC} = 4.5V$ | | |
| Logic Low Output Voltage | $V_{OL}$ | | 0.2 | 0.5 | V | $I_F = 8mA$, $I_O = 0.7mA$, $V_{CC} = 4.5V$ | | 5 |
| Logic Low Supply Current | $I_{CCL}$ | | 40 | | µA | $I_{F1} = I_{F2} = 8mA$<br>$V_{O1} = V_{O2} =$ Open, $V_{CC} = 5.5V$ | | |
| Input Forward Voltage | $V_F$ | | 1.5 | 1.7 | V | $I_F = 8mA$, $T_A = 25°C$ | 2 | 5 |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | | -1.6 | | mV/°C | $I_F = 8mA$ | | 5 |

# Switching Specifications at $T_A = 25°C$

$V_{CC} = 5V$, $I_F = 8mA$, $R_L = 7.5k\Omega$ unless otherwise specified.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to Logic Low at Output | $t_{PHL}$ | | 0.8 | 1.5 | µs | | 4,6 | 10 |
| Propagation Delay Time to Logic High at Output | $t_{PLH}$ | | 1.0 | 2.5 | µs | | 4,6 | 10 |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ | | 1000 | | V/µs | $I_F = 0mA$, $V_{CM} = 10V_{p-p}$ | 7 | 9,10 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ | | -1000 | | V/µs | $V_{CM} = 10V_{p-p}$ | 7 | 9,10 |

# Electrical Specifications, TTL/LSTTL

Over recommended temperature ($T_A = 0°C$ to $70°C$) unless otherwise specified.

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR | 12 | 18 | | % | $I_F = 16mA$, $V_O = 0.5V$, $V_{CC} = 4.5V$, $T_A = 25°C$ | 1 | 5,5 |
| | | 9 | 13 | | % | $I_F = 16mA$, $V_O = 0.5V$, $V_{CC} = 4.5V$ | | |
| Logic Low Output Voltage | $V_{OL}$ | | 0.2 | 0.5 | V | $I_F = 16mA$, $I_O = 1.1mA$, $V_{CC} = 4.5V$ | | 5 |
| Logic Low Supply Current | $I_{CCL}$ | | 80 | | µA | $I_{F1} = I_{F2} = 16mA$<br>$V_{O1} = V_{O2} =$ Open, $V_{CC} = 5.5V$ | | |
| Input Forward Voltage | $V_F$ | | 1.5 | 1.7 | V | $I_F = 16mA$, $T_A = 25°C$ | 2 | 5 |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | | -1.6 | | mV/°C | $I_F = 16mA$ | | 5 |

# Switching Specifications at $T_A = 25°C$

$V_{CC} = 5V$, $I_F = 16mA$, $R_L = 4.7k\Omega$ unless otherwise specified.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to Logic Low at Output | $t_{PHL}$ | | 0.3 | 1.5 | µs | | 4,6 | 11 |
| Propagation Delay Time to Logic High at Output | $t_{PLH}$ | | 1.1 | 2.5 | µs | | 4,6 | 11 |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ | | 1000 | | V/µs | $I_F = 0mA$, $V_{CM} = 10V_{p-p}$ | 7 | 9,11 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ | | -1000 | | V/µs | $V_{CM} = 10V_{p-p}$ | 7 | 9,11 |

*All typicals at 25°C.

(See following page for notes.)

# Electrical Specifications

Over recommended temperature ($T_A = 0°C$ to $70°C$) unless otherwise specified

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Logic High Output Current | $I_{OH}$ | | 0.5 | | nA | $T_A = 25°C$, $I_{F1} = I_{F2} = 0mA$<br>$V_{O1} = V_{O2} = V_{CC} = 5.5V$ | 5 | 5 |
| | | | | 50 | μA | $I_{F1} = I_{F2} = 0$ mA<br>$V_{O1} = V_{O2} = V_{CC} = 5.5V$ | | 5 |
| Logic High Supply Current | $I_{CCH}$ | | 0.05 | 4 | μA | $I_{F1} = I_{F2} = 0$ mA<br>$V_{O1} = V_{O2} =$ Open, $V_{CC} = 5.5V$ | | |
| Input Reverse Breakdown Voltage | $V_R$ | 5 | | | V | $I_F = 10$ μA, $T_A = 25°C$ | | 5 |
| Input Capacitance | $C_{IN}$ | | 60 | | pF | f = 1 MHz, $V_F = 0$ V | | 5 |
| Input-Output Insulation Leakage Current | $I_{I-O}$ | | | 1.0 | μA | 45% Relative Humidity, t = 5s<br>$V_{I-O} = 3000V$ dc, $T_A = 25°C$ | | 7 |
| Resistance (Input-Output) | $R_{I-O}$ | | $10^{12}$ | | Ω | $V_{I-O} = 500V$ dc | | 7 |
| Capacitance (Input-Output) | $C_{I-O}$ | | 0.6 | | pF | f = 1 MHz | | 7 |
| Input-Input Insulation Leakage Current | $I_{I-I}$ | | 0.005 | | μA | 45% Relative Humidity, t = 5s<br>$V_{I-I} = 500V$ dc | | 8 |
| Resistance (Input-Input) | $R_{I-I}$ | | $10^{11}$ | | Ω | $V_{I-I} = 500V$ dc | | 8 |
| Capacitance (Input-Input) | $C_{I-I}$ | | 0.25 | | pF | f = 1 MHz | | 8 |

**Notes:**

1. Derate linearly above 70° C free-air temperature at a rate of 0.8mA/° C.
2. Derate linearly above 70° C free-air temperature at a rate of 1.6mA/° C.
3. Derate linearly above 70° C free-air temperature at a rate of 0.9mW/° C.
4. Derate linearly above 70° C free-air temperature at a rate of 1.0mW/° C.
5. Each channel.
6. CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
7. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
8. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
9. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the leading edge of the common mode pulse $V_{CM}$, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM}/dt$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$).
10. The 7.5k load represents 1 LSTTL until load of 0.36mA and a 20kΩ pull-up resistor.
11. The 4.7k load represents 1 LSTTL unit load of 0.36mA and an 8.2kΩ pull-up resistor.

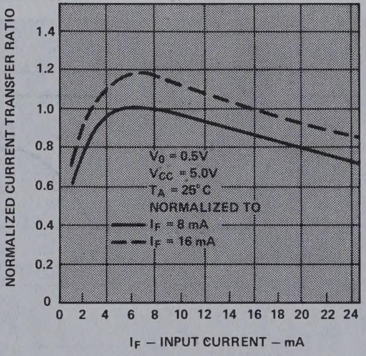


**Figure 1. Current Transfer Ratio vs. Input Current**

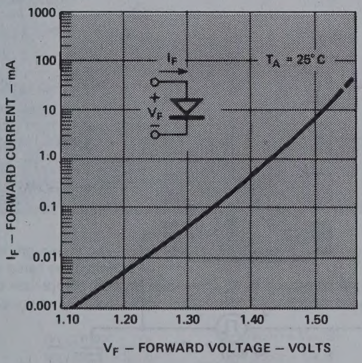


**Figure 2. Input Current vs. Forward Voltage**

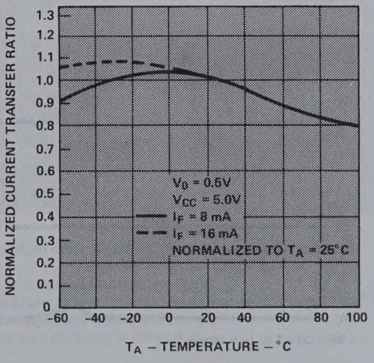


**Figure 3. Current Transfer Ratio vs. Temperature**

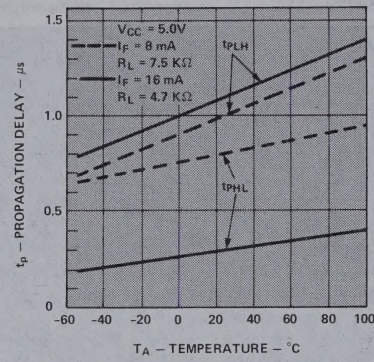


Figure 4. Propagation Delay vs. Temperature

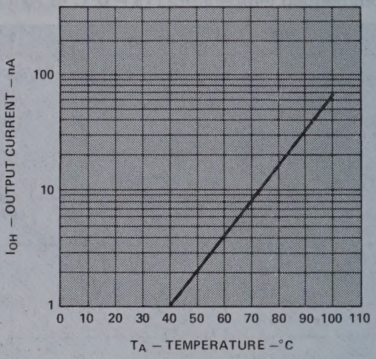
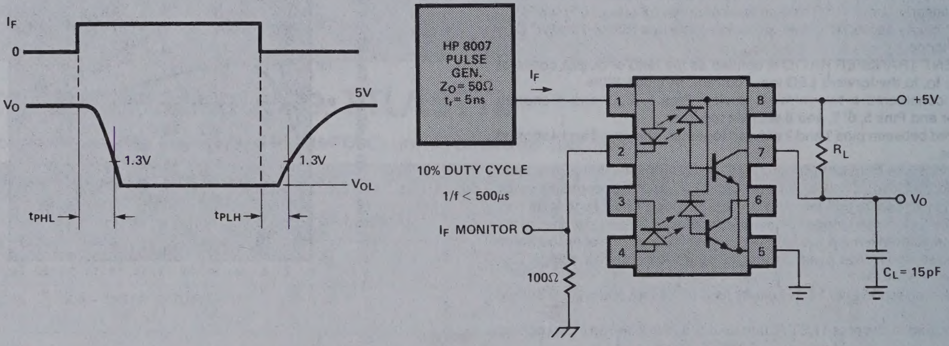
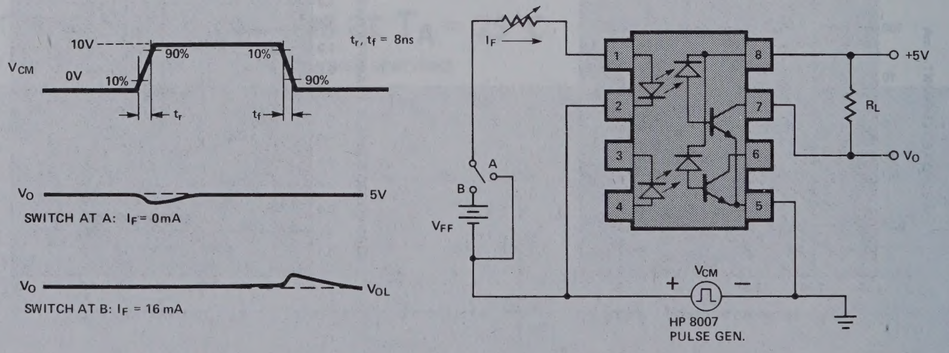


Figure 5. Logic High Output Current vs. Temperature



IF
0
VO
5V
1.3V
1.3V
VOL
tPHL
tPLH
HP 8007
PULSE
GEN.
ZO = 50Ω
tr = 5ns
IF
10% DUTY CYCLE
1/f < 500μs
IF MONITOR
100Ω
1
2
3
4
8
7
6
5
+5V
RL
VO
CL = 15pF

Figure 6. Switching Test Circuit

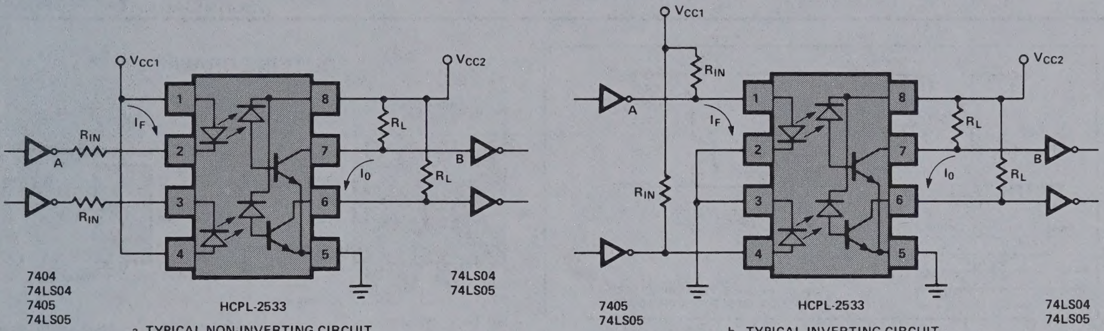


10V
VCM
0V
10%
90%
10%
90%
tr, tf = 8ns
tr
tf
VO
5V
SWITCH AT A: IF = 0mA
VO
VOL
SWITCH AT B: IF = 16 mA
IF
A
B
VFF
1
2
3
4
8
7
6
5
+5V
RL
VO
VCM
+
–
HP 8007
PULSE GEN.

Figure 7. Test Circuit for Transient Immunity and Typical Waveforms

# Recommended Operation

The HCPL-2533 optocoupler is specified for use in LSTTL-to-LSTTL and TTL-to-LSTTL interfaces. The recommended circuits show the interface design and give suggested component values. The input current $I_F$ is given as both a nominal value and a range. The range in $I_F$ results from the tolerances in $V_{CC}$ and the input resistor $R_{IN}$. The CTR of the optocoupler is given as the minimum initial value over temperature, taken directly from the Electrical Specifications. The value given for $I_{OL}$(min) is based on the minimum CTR and the minimum $I_F$ using worst case values for $R_L$ and $V_{CC}$. The resulting $I_{OL}$(min) has ample design margin, allowing more than 20% for CTR degradation even under these worst case conditions. For additional information on CTR degradation see Application Note 1002.



a. TYPICAL NON-INVERTING CIRCUIT

b. TYPICAL INVERTING CIRCUIT (SEE NOTE 12)

Figure 8. Recommended Circuits

# Recommended Circuit Design Parameters

| Parameter | Symbol | LSTTL to LSTTL | TTL to LSTTL | Units | Comments | Fig. | Note |
|---|---|---|---|---|---|---|---|
| **INPUT** | | | | | | | |
| Logic Low Output Voltage — Input Gate | $V_{OL}$(A) | 0.5 | 0.4 | V | Maximum | | |
| Supply Voltage — Input | $V_{CC1}$ | 5.0 | 5.0 | V | ±5% | | |
| Input Resistor | $R_{IN}$ | 360 | 180 | Ω | ±5% | 8a | |
| | | 430 | 200 | | | 8b | |
| Input Current | $I_F$ | 8 | 16 | mA | Nominal | | |
| Input Current Range | $I_F$ | 6.75—10 | 14.0—20 | mA | | 8a | |
| | | | 14.5—20 | | | 8b | |
| **OUTPUT** | | | | | | | |
| Logic Low Output Voltage — HCPL-2533 | $V_{OL}$(B) | 0.5 | 0.5 | V | Maximum | | |
| Supply Voltage — Output | $V_{CC2}$ | 5.0 | 5.0 | V | ±5% | | |
| Pull-Up Resistor | $R_L$ | 20 | 8.2 | kΩ | ±5% | | 13 |
| Required Current Sink for Logic Low | $I_{OL}$ (max) | 0.61 | 1.0 | mA | Worst Case $V_{CC}$, $R_L$, $I_{IL}$(B) | | 14 |
| HCPL-2533 Current Transfer Ratio | CTR | 11 | 9 | % | Minimum $T_A = 0°C$ to $+70°C$ | | |
| Logic Low Output Current — HCPL-2533 | $I_{OL}$ (min) | 0.74 | 1.26 | mA | Worst Case $V_{CC}$, CTR, $I_F$ $T_A = 0°C$ to $+70°C$ | 8a | 15 |
| | | | 1.30 | | | 8b | |
| Data Rate | $f_D$ | 250 | 250 | Kb/s | NRZ, $T_A = 25°C$ | | 16 |

**Notes:**

12. The inverting circuit has higher power consumption and must use open collector gates on the input.
13. The load resistor $R_L$ must be large enough to guarantee logic LOW and small enough to guarantee logic HIGH under worst case conditions:

$$\frac{V_{CC}(\text{max}) - V_{OL}}{I_{OL}(2533) - I_{IL}(B)} \le R_L \le \frac{V_{CC}(\text{min}) - V_{IH}(B)}{I_{OH}(2533) - I_{IH}(B)}$$

The selection of $R_L$ is the same for both inverting and non-inverting circuits.

14. The maximum current sink required for logic LOW is:

$$I_{OL}(\text{max}) = I_{IL}(B)(\text{max}) + I_R(\text{max})$$

where $I_R$ is the current through $R_L$.

15. The ratio of $I_{OL}$(min) to $I_{OL}$(max) gives the design margin for CTR degradation. See Application Note 1002.
16. The maximum data rate is defined as

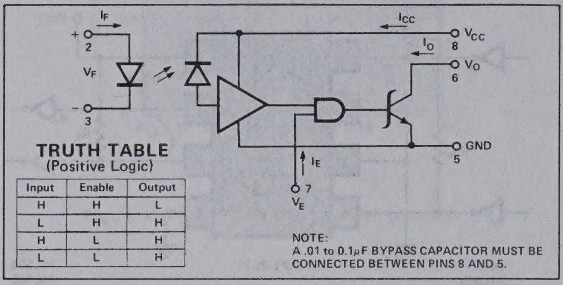
$$f_D = \frac{1}{t_{PHL} + t_{PLH}} \text{ bits/second NRZ}$$

HEWLETT PACKARD

# LSTTL/TTL COMPATIBLE OPTOCOUPLER

**6N137**

TECHNICAL DATA FEBRUARY 198



$I_F$
+
2
$V_F$
–
3
$I_{CC}$
$V_{CC}$
8
$I_O$
$V_O$
6
GND
5
$I_E$
7
$V_E$

**TRUTH TABLE**
(Positive Logic)

| Input | Enable | Output |
|---|---|---|
| H | H | L |
| L | H | H |
| H | L | H |
| L | L | H |

NOTE:
A .01 to 0.1μF BYPASS CAPACITOR MUST BE CONNECTED BETWEEN PINS 8 AND 5.

**Figure 1.**

## Features

- LSTTL/TTL COMPATIBLE: 5V SUPPLY
- ULTRA HIGH SPEED
- LOW INPUT CURRENT REQUIRED
- HIGH COMMON MODE REJECTION
- GUARANTEED PERFORMANCE OVER TEMPERATURE
- 3000 Vdc WITHSTAND TEST VOLTAGE
- RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)

## Description Applications

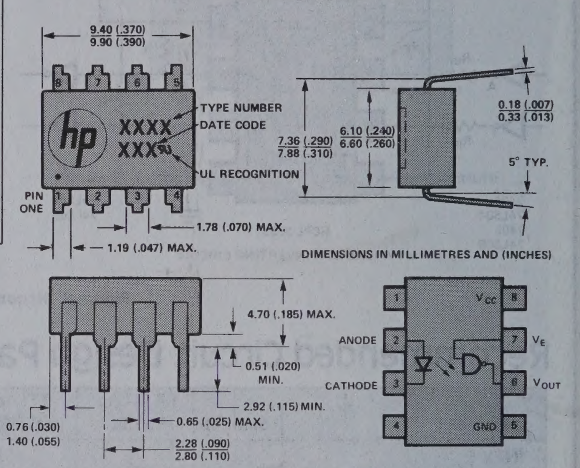
The 6N137 consists of a GaAsP photon emitting diode and a unique integrated detector. The photons are collected in the detector by a photodiode and then amplified by a high gain linear amplifier that drives a Schottky clamped open collector output transistor. The circuit is temperature, current and voltage compensated.

This unique isolator design provides maximum DC and AC circuit isolation between input and output while achieving LSTTL/TTL circuit compatibility. The isolator operational parameters are guaranteed from 0°C to 70°C, such that a minimum input current of 5mA will sink an eight gate fan-out (13mA) at the output with 5 volt $V_{CC}$ applied to the detector. This isolation and coupling is achieved with a typical propagation delay of 45ns. The enable input provides gating of the detector with input sinking and sourcing requirements compatible with LSTTL/TTL interfacing and a propagation delay of 25ns typical.

The 6N137 can be used in high speed digital interfacing applications where common mode signals must be rejected, such as for a line receiver and digital programming of floating power supplies, motors, and other machine control systems. The elimination of ground loops can be accomplished in system interfaces such as between a computer and a peripheral memory, printer, controller, etc.

The open collector output provides capability for bussing, OR'ing and strobing.

**OUTLINE DRAWING***



9.40 (.370)
9.90 (.390)
8
7
6
5
XXXX
XXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
PIN ONE
1
2
3
4
1.78 (.070) MAX.
1.19 (.047) MAX.
DIMENSIONS IN MILLIMETRES AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
ANODE
CATHODE
$V_{CC}$
$V_E$
$V_{OUT}$
GND

## Recommended Operating Conditions

| | Sym. | Min. | Max. | Units |
|---|---|---|---|---|
| Input Current, Low Level Each Channel | $I_{FL}$ | 0 | 250 | μA |
| Input Current, High Level Each Channel | $I_{FH}$ | 6.3** | 15 | mA |
| High Level Enable Voltage | $V_{EH}$ | 2.0 | $V_{CC}$ | V |
| Low Level Enable Voltage (Output High) | $V_{EL}$ | 0 | 0.8 | V |
| Supply Voltage, Output | $V_{CC}$ | 4.5 | 5.5 | V |
| Fan Out (TTL Load) | N | | 8 | |
| Operating Temperature | $T_A$ | 0 | 70 | °C |

## Absolute Maximum Ratings*

(No derating required up to 70°C)

| | |
|---|---|
| Storage Temperature | −55°C to +125°C |
| Operating Temperature | 0°C to +70°C |
| Lead Solder Temperature | 260°C for 10s (1.6mm below seating plane) |
| Peak Forward Input Current | 40mA (1≤ 1msec Duration) |
| Average Forward Input Current | 20mA |
| Reverse Input Voltage | 5V |
| Enable Input Voltage | 5.5V (Not to exceed $V_{CC}$ by more than 500mV) |
| Supply Voltage - $V_{CC}$ | 7V (1 Minute Maximum) |
| Output Current - $I_O$ | 50mA |
| Output Collector Power Dissipation | 85mW |
| Output Voltage - $V_O$ | 7V |

**6.3mA condition permits at least 20% CTR degradation guardband. Initial switching threshold is 5mA or less.

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*JEDEC Registered Data.

# lectrical Characteristics

## VER RECOMMENDED TEMPERATURE ($T_A$ = 0°C TO 70°C) UNLESS OTHERWISE NOTED

| Parameter | Symbol | Min. | Typ.** | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| High Level Output Current | $I_{OH}$* | | 50 | 250 | μA | $V_{CC}$=5.5V, $V_O$=5.5V,<br>$I_F$=250μA, $V_E$=2.0V | 6 | |
| Low Level Output Voltage | $V_{OL}$* | | 0.5 | 0.6 | V | $V_{CC}$=5.5V, $I_F$=5mA,<br>$V_{EH}$=2.0V<br>$I_{OL}$ (Sinking) =13mA | 3,5 | |
| High Level Enable Current | $I_{EH}$ | | -1.0 | | mA | $V_{CC}$=5.5V, $V_E$=2.0V | | |
| Low Level Enable Current | $I_{EL}$* | | -1.6 | -2.0 | mA | $V_{CC}$=5.5V, $V_E$=0.5V | | |
| High Level Supply Current | $I_{CCH}$* | | 7 | 15 | mA | $V_{CC}$=5.5V, $I_F$=0<br>$V_E$=0.5V | | |
| Low Level Supply | $I_{CCL}$* | | 13 | 18 | mA | $V_{CC}$=5.5V, $I_F$=10mA<br>$V_E$=0.5V | | |
| Input-Output Insulation Leakage Current | $I_{I\text{-}O}$* | | | 1.0 | μA | Relative Humidity=45%<br>$T_A$=25°C, t=5s<br>$V_{I\text{-}O}$=3000Vdc | | 5 |
| Resistance (Input-Output) | $R_{I\text{-}O}$ | | $10^{12}$ | | Ω | $V_{I\text{-}O}$=500V, $T_A$=25°C | | 5 |
| Capacitance (Input-Output) | $C_{I\text{-}O}$ | | 0.6 | | pF | f=1MHz, $T_A$=25°C | | 5 |
| Input Forward Voltage | $V_F$* | | 1.5 | 1.75 | V | $I_F$=10mA, $T_A$=25°C | 4 | 8 |
| Input Reverse Breakdown Voltage | $BV_R$* | 5 | | | V | $I_R$=10μA, $T_A$=25°C | | |
| Input Capacitance | $C_{IN}$ | | 60 | | pF | $V_F$=0, f=1MHz | | |
| Current Transfer Ratio | CTR | | 700 | | % | $I_F$=5.0mA, $R_L$=100Ω | 2 | 7 |

All typical values are at $V_{CC}$ = 5V, $T_A$ = 25°C

# witching Characteristics at $T_A$=25°C, $V_{CC}$=5V

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to High Output Level | $t_{PLH}$* | | 45 | 75 | ns | $R_L$=350Ω, $C_L$=15pF,<br>$I_F$=7.5mA | 7,9 | 1 |
| Propagation Delay Time to Low Output Level | $t_{PHL}$* | | 45 | 75 | ns | $R_L$=350Ω, $C_L$=15pF,<br>$I_F$=7.5mA | 7,9 | 2 |
| Output Rise-Fall Time (10-90%) | $t_r$, $t_f$ | | 25 | | ns | $R_L$=350Ω, $C_L$=15pF,<br>$I_F$=7.5mA | | |
| Propagation Delay Time of Enable from $V_{EH}$ to $V_{EL}$ | $t_{ELH}$ | | 65 | | ns | $R_L$=350Ω, $C_L$=15pF,<br>$I_F$=7.5mA, $V_{EH}$=3.0V,<br>$V_{EL}$=0.5V | 8 | 3 |
| Propagation Delay Time of Enable from $V_{EL}$ to $V_{EH}$ | $t_{EHL}$ | | 15 | | ns | $R_L$=350Ω, $C_L$=15pF,<br>$I_F$=7.5mA $V_{EH}$=3.0V,<br>$V_{EL}$=0.5V | 8 | 4 |
| Common Mode Transient Immunity at Logic High Output Level | $CM_H$ | | 50 | | v/μs | $V_{CM}$=10V $R_L$=350Ω,<br>$V_O$(min.)=2V, $I_F$=0mA | 11 | 6 |
| Common Mode Transient Immunity at Logic Low Output Level | $CM_L$ | | -150 | | v/μs | $V_{CM}$=10V $R_L$=350Ω,<br>$V_O$(max.)=0.8V,<br>$I_F$=5mA | 11 | 6 |

EDEC Registered Data.

# Operating Procedures and Definitions

**Logic Convention.** The 6N137 is defined in terms of positive logic.

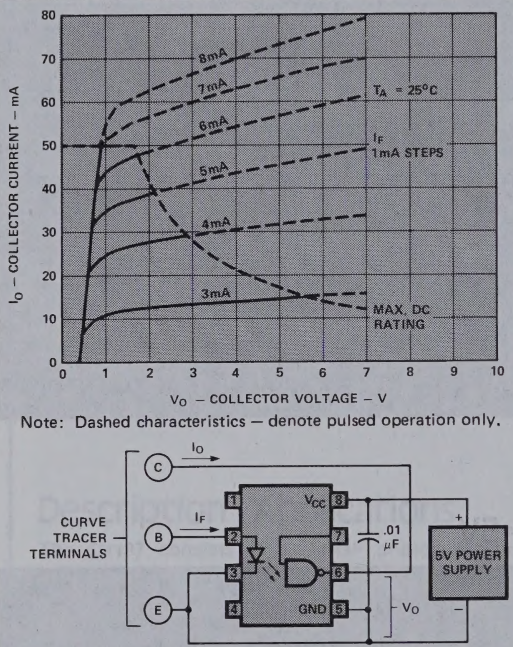
**Bypassing.** A ceramic capacitor (.01 to 0.1µF) should be connected from pin 8 to pin 5 (Figure 12). Its purpose is to stabilize the operation of the high gain linear amplifier. Failure to provide the bypassing may impair the switching properties. The total lead length between capacitor and coupler should not exceed 20mm.

**Polarities.** All voltages are referenced to network ground (pin 5). Current flowing toward a terminal is considered positive.

**Enable Input.** No external pull-up required for a logic (1), i.e., can be open circuit.

**NOTES:**

1. The $t_{PLH}$ propagation delay is measured from the 3.75mA point on the trailing edge of the input pulse to the 1.5V point on the trailing edge of the output pulse.
2. The $t_{PHL}$ propagation delay is measured from the 3.75mA point on the leading edge of the input pulse to 1.5V point on the leading edge of the output pulse.
3. The $t_{ELH}$ enable propagation delay is measured from the 1.5V point of the trailing edge of the input pulse to the 1.5V point on the trailing edge of the output pulse.
4. The $t_{EHL}$ enable propagation delay is measured from the 1.5V point on the leading edge of the input pulse to the 1.5V point on the leading edge of the output pulse.
5. Device considered a two terminal device: pins 2 and 3 shorted together, and pins 5, 6, 7, and 8 shorted together.
6. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the leading edge of the common mode pulse, $V_{CM}$, to assure that the output will remain in a Logic High state (i.e., $V_O>2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM}/dt$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a Logic Low state (i.e., $V_O<0.8V$).
7. DC Current Transfer Ratio is defined as the ratio of the output collector current to the forward bias input current times 100%.
8. At 10mA $V_F$ decreases with increasing temperature at the rate of 1.6mV/°C.



Note: Dashed characteristics — denote pulsed operation only.

Figure 2. Optocoupler Collector Characteristics.

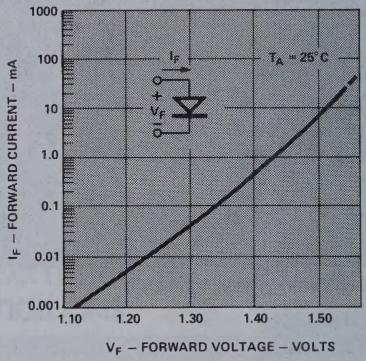


Figure 4. Input Diode Forward Characteristic.

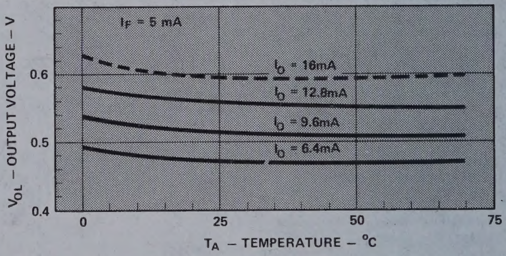


Figure 5. Output Voltage, $V_{OL}$ vs. Temperature and Fan-Out.

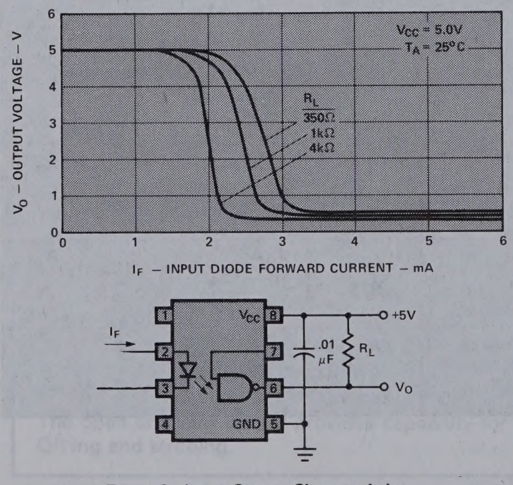


Figure 3. Input-Output Characteristics.

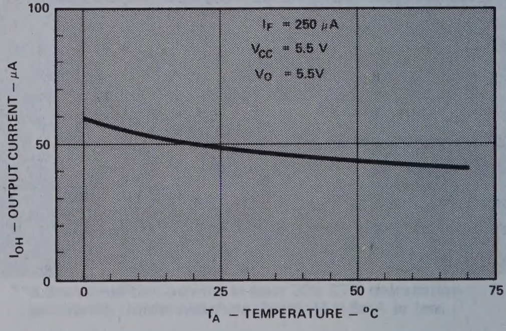


Figure 6. Output Current, $I_{OH}$ vs. Temperature ($I_F$=250µA).

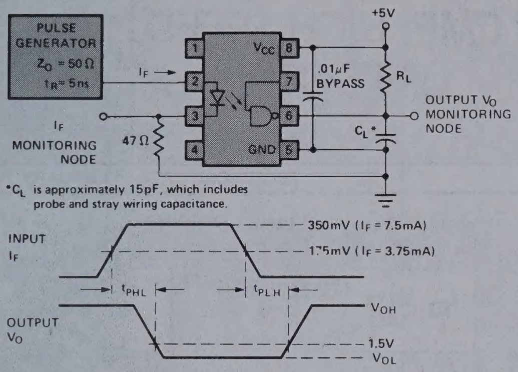

PULSE GENERATOR
$Z_O = 50\ \Omega$
$t_R = 5ns$
$I_F$
$I_F$
MONITORING NODE
47 Ω
+5V
$V_{CC}$
GND
1
2
3
4
5
6
7
8
.01μF BYPASS
$R_L$
OUTPUT $V_O$ MONITORING NODE
$C_L$*
*$C_L$ is approximately 15pF, which includes probe and stray wiring capacitance.
INPUT $I_F$
350mV ($I_F$ = 7.5mA)
175mV ($I_F$ = 3.75mA)
$t_{PHL}$
$t_{PLH}$
OUTPUT $V_O$
$V_{OH}$
1.5V
$V_{OL}$

Figure 7. Test Circuit for $t_{PHL}$ and $t_{PLH}$.**

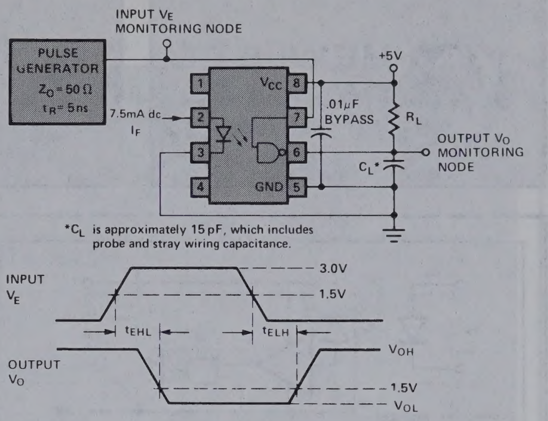

INPUT $V_E$ MONITORING NODE
PULSE GENERATOR
$Z_O = 50\ \Omega$
$t_R = 5ns$
7.5mA dc
$I_F$
+5V
$V_{CC}$
GND
1
2
3
4
5
6
7
8
.01μF BYPASS
$R_L$
OUTPUT $V_O$ MONITORING NODE
$C_L$*
*$C_L$ is approximately 15pF, which includes probe and stray wiring capacitance.
INPUT $V_E$
3.0V
1.5V
$t_{EHL}$
$t_{ELH}$
OUTPUT $V_O$
$V_{OH}$
1.5V
$V_{OL}$

Figure 8. Test Circuit for $t_{ELH}$ and $t_{EHL}$.

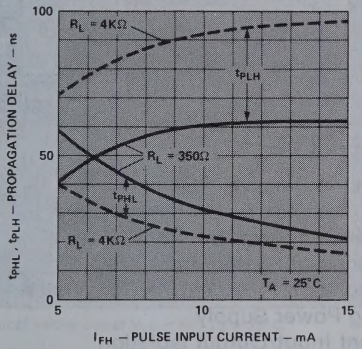


Figure 9. Propagation Delay, $t_{PHL}$ and $t_{PLH}$ vs. Pulse Input Current, $I_{FH}$.

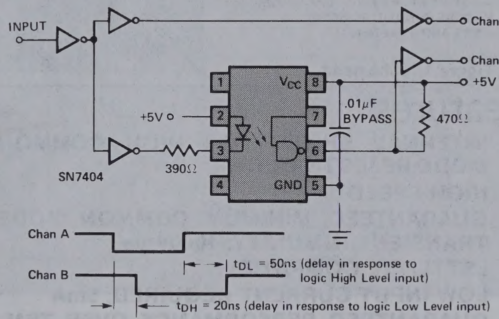

INPUT
Chan A
Chan B
+5V
+5V
$V_{CC}$
GND
1
2
3
4
5
6
7
8
.01μF BYPASS
470Ω
390Ω
SN7404
Chan A
Chan B
$t_{DL}$ = 50ns (delay in response to logic High Level input)
$t_{DH}$ = 20ns (delay in response to logic Low Level input)

Figure 10. Response Delay Between TTL Gates.

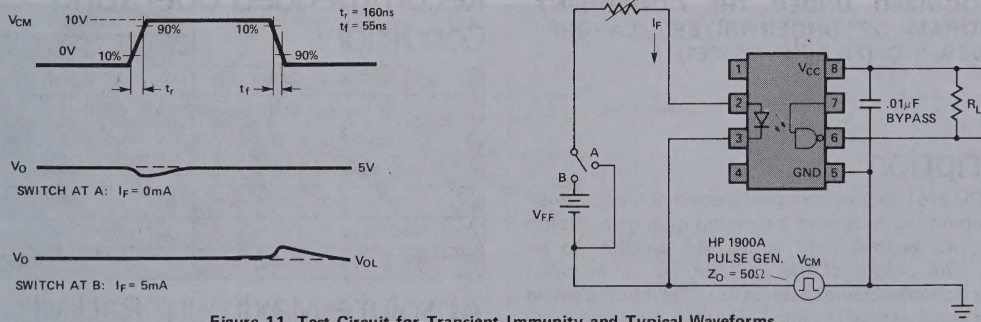

$V_{CM}$
10V
0V
90%
10%
10%
90%
$t_r$ = 160ns
$t_f$ = 55ns
$t_r$
$t_f$
$V_O$
5V
SWITCH AT A: $I_F$ = 0mA
$V_O$
$V_{OL}$
SWITCH AT B: $I_F$ = 5mA
$I_F$
A
B
$V_{FF}$
$V_{CC}$
GND
1
2
3
4
5
6
7
8
+5V
.01μF BYPASS
$R_L$
$V_O$
HP 1900A PULSE GEN.
$Z_O$ = 50Ω
$V_{CM}$

Figure 11. Test Circuit for Transient Immunity and Typical Waveforms.

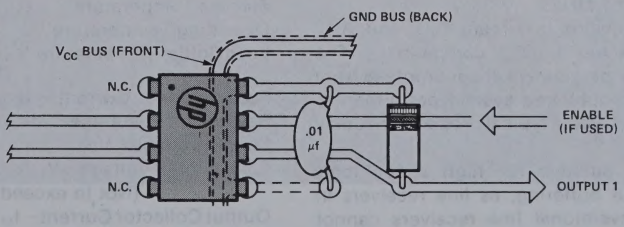

GND BUS (BACK)
$V_{CC}$ BUS (FRONT)
N.C.
N.C.
.01 μf
ENABLE (IF USED)
OUTPUT 1

Figure 12. Recommended Printed Circuit Board Layout.

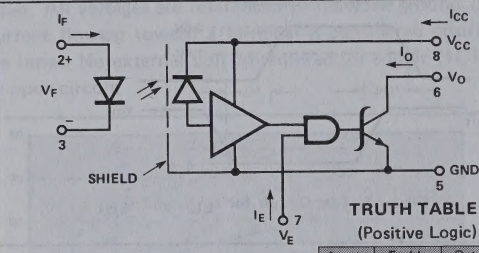
JEDEC Registered Data.

**HEWLETT PACKARD**

# HIGH CMR, HIGH SPEED OPTOCOUPLER

## HCPL - 2601

TECHNICAL DATA FEBRUARY 1982


I_F
2+
V_F
3
SHIELD
I_CC
V_CC 8
I_O
V_O 6
GND 5
I_E
7
V_E

**TRUTH TABLE**
(Positive Logic)

| Input | Enable | Output |
|---|---|---|
| H | H | L |
| L | H | H |
| H | L | H |
| L | L | H |

A 0.01 TO 0.1 μF BYPASS CAPACITOR MUST BE CONNECTED BETWEEN PINS 8 AND 5 (See Note 1).

Figure 1. Schematic.

## Features

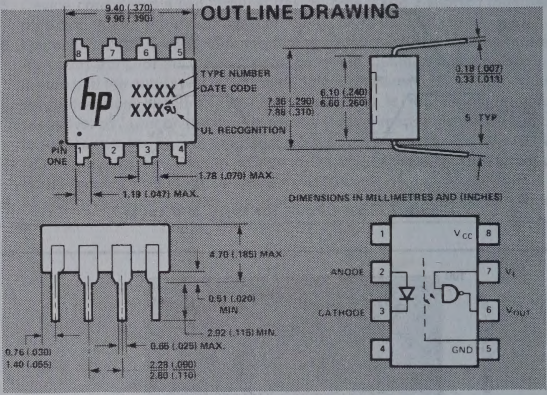
- INTERNAL SHIELD FOR HIGH COMMON MODE REJECTION (CMR)
- HIGH SPEED
- GUARANTEED MINIMUM COMMON MODE TRANSIENT IMMUNITY: 1000V/μs
- LSTTL/TTL COMPATIBLE
- LOW INPUT CURRENT REQUIRED: 5mA
- GUARANTEED PERFORMANCE OVER TEMPERATURE: 0°C to 70°C
- STROBABLE OUTPUT
- 3000 Vdc WITHSTAND TEST VOLTAGE
- RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)

## Description

The HCPL-2601 optically coupled gate combines a GaAsP light emitting diode and an integrated high gain photon detector. An enable input allows the detector to be strobed. The output of the detector I.C. is an open collector Schottky clamped transistor. The internal shield provides a guaranteed common mode transient immunity specification of 1000 volts/μsec., equivalent to rejecting a 300 volt P-P sinusoid at 1 MHz.

This unique design provides maximum D.C. and A.C. circuit isolation while achieving TTL compatibility. The isolator D.C. operational parameters are guaranteed from 0°C to 70°C allowing troublefree system performance. This isolation is achieved with a typical propagation delay of 35 nsec.

The HCPL-2601's are suitable for high speed logic interfacing, input/output buffering, as line receivers in environments that conventional line receivers cannot tolerate and are recommended for use in extremely high ground or induced noise environments.


OUTLINE DRAWING
9.40 (.370)
9.90 (.390)
8
7
6
5
hp
XXXX
XXXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
PIN ONE
1
2
3
4
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP
1.78 (.070) MAX.
1.19 (.047) MAX.
DIMENSIONS IN MILLIMETRES AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
V_CC
ANODE
CATHODE
V_E
V_OUT
GND

## Applications

- Isolated Line Receiver
- Simplex/Multiplex Data Transmission
- Computer-Peripheral Interface
- Microprocessor System Interface
- Digital Isolation for A/D, D/A Conversion
- Switching Power Supply
- Instrument Input/Output Isolation
- Ground Loop Elimination
- Pulse Transformer Replacement

## Recommended Operating Conditions

| | Sym. | Min. | Max. | Units |
|---|---|---|---|---|
| Input Current, Low Level | $I_{FL}$ | 0 | 250 | μA |
| Input Current, High Level | $I_{FH}$ | 6.3* | 15 | mA |
| Supply Voltage, Output | $V_{CC}$ | 4.5 | 5.5 | V |
| High Level Enable Voltage | $V_{EH}$ | 2.0 | $V_{CC}$ | V |
| Low Level Enable Voltage | $V_{EL}$ | 0 | 0.8 | V |
| Fan Out (TTL Load) | N | | 8 | |
| Operating Temperature | $T_A$ | 0 | 70 | °C |

## Absolute Maximum Ratings

(No Derating Required up to 70°C)

| | |
|---|---|
| Storage Temperature | −55°C to +125°C |
| Operating Temperature | 0°C to +70°C |
| Lead Solder Temperature | 260°C for 10 s<br>(1.6mm below seating plane) |
| Forward Input Current − $I_F$ (see Note 2) | 20 mA |
| Reverse Input Voltage | 5 V |
| Supply Voltage − $V_{CC}$ | 7V (1 Minute Maximum) |
| Enable Input Voltage − $V_E$ | 5.5 V<br>(Not to exceed $V_{CC}$ by more than 500 mV) |
| Output Collector Current − $I_O$ | 25 mA |
| Output Collector Power Dissipation | 40 mW |
| Output Collector Voltage − $V_O$ | 7 V |

*6.3mA condition permits at least 20% CTR degradation guardband. Initial switching threshold is 5mA or less.

# Electrical Characteristics

(Over Recommended Temperature, $T_A$ = 0°C to +70°C, Unless Otherwise Noted)

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| High Level Output Current | $I_{OH}$ | | 7 | 250 | μA | $V_{CC}$ = 5.5V, $V_O$ = 5.5V,<br>$I_F$ = 250 μA, $V_E$ = 2.0 V | 2 | |
| Low Level Output Voltage | $V_{OL}$ | | 0.4 | 0.6 | V | $V_{CC}$ = 5.5V, $I_F$ = 5 mA<br>$V_E$ = 2.0 V,<br>$I_{OL}$ (Sinking) = 13 mA | 3,5 | |
| High Level Supply Current | $I_{CCH}$ | | 10 | 15 | mA | $V_{CC}$ = 5.5V, $I_F$ = 0,<br>$V_E$ = 0.5 V | | |
| Low Level Supply Current | $I_{CCL}$ | | 15 | 19 | mA | $V_{CC}$ = 5.5V, $I_F$ = 10 mA,<br>$V_E$ = 0.5 V | | |
| Low Level Enable Current | $I_{EL}$ | | −1.6 | −2.0 | mA | $V_{CC}$ = 5.5 V, $V_E$ = 0.5 V | | |
| High Level Enable Current | $I_{EH}$ | | −1.0 | | mA | $V_{CC}$ = 5.5 V, $V_E$ = 2.0V | | |
| High Level Enable Voltage | $V_{EH}$ | 2.0 | | | V | | | 11 |
| Low Level Enable Voltage | $V_{EL}$ | | | 0.8 | V | | | |
| Input Forward Voltage | $V_F$ | | 1.5 | 1.75 | V | $I_F$ = 10 mA, $T_A$ = 25°C | 4 | |
| Input Reverse Breakdown Voltage | $BV_R$ | 5 | | | V | $I_R$ = 10 μA, $T_A$ = 25°C | | |
| Input Capacitance | $C_{IN}$ | | 60 | | pF | $V_F$ = 0, f = 1 MHz | | |
| Input Diode Temperature Coefficient | $\frac{\Delta V_F}{\Delta T_A}$ | | −1.6 | | mV/°C | $I_F$ = 10 mA | | |
| Input-Output Insulation Leakage Current | $I_{I-O}$ | | | 1 | μA | Relative Humidity = 45%<br>$T_A$ = 25°C, t = 5 s,<br>$V_{I-O}$ = 3000 Vdc | | 3 |
| Resistance (Input-Output) | $R_{I-O}$ | | $10^{12}$ | | Ω | $V_{I-O}$ = 500 V | | 3 |
| Capacitance (Input-Output) | $C_{I-O}$ | | 0.6 | | pF | f = 1 MHz | | 3 |

*All typical values are at $V_{CC}$ = 5V, $T_A$ = 25°C.

# Switching Characteristics ($T_A$ = 25°C, $V_{CC}$ = 5V)

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to High Output level | $t_{PLH}$ | | 35 | 75 | ns | $R_L$ = 350 Ω<br>$C_L$ = 15 pF<br>$I_F$ = 7.5 mA | 6 | 4 |
| Propagation Delay Time to Low Output Level | $t_{PHL}$ | | 35 | 75 | ns | | 6 | 5 |
| Output Rise Time (10–90%) | $t_r$ | | 25 | | ns | | | |
| Output Fall Time (90–10%) | $t_f$ | | 15 | | ns | | | |
| Propagation Delay Time of Enable from $V_{EH}$ to $V_{EL}$ | $t_{ELH}$ | | 25 | | ns | $R_L$ = 350 Ω, $C_L$ = 15 pF,<br>$I_F$ = 7.5 mA, $V_{EH}$ = 3 V,<br>$V_{EL}$ = 0 V | 9 | 6 |
| Propagation Delay Time of Enable from $V_{EL}$ to $V_{EH}$ | $t_{EHL}$ | | 15 | | ns | $R_L$ = 350 Ω, $C_L$ = 15 pF,<br>$I_F$ = 7.5 mA, $V_{EH}$ = 3 V,<br>$V_{EL}$ = 0 V | 9 | 7 |
| Common Mode Transient Immunity at High Output Level | $CM_H$ | 1000 | 10,000 | | V/μs | $V_{CM}$ = 50 V (peak),<br>$V_O$ (min.) = 2 V,<br>$R_L$ = 350 Ω, $I_F$ = 0 mA | 12 | 8,10 |
| Common Mode Transient Immunity at Low Output Level | $CM_L$ | −1000 | −10,000 | | V/μs | $V_{CM}$ = 50 V (peak),<br>$V_O$ (max.) = 0.8 V,<br>$R_L$ = 350 Ω, $I_F$ = 7.5 mA | 12 | 9,10 |

NOTES:

1. Bypassing of the power supply line is required, with a 0.01 $\mu$F ceramic disc capacitor adjacent to each isolator as illustrated in Figure 15. The power supply bus for the isolator(s) should be separate from the bus for any active loads, otherwise a larger value of bypass capacitor (up to 0.1 $\mu$F) may be needed to suppress regenerative feedback via the power supply.
2. Peaking circuits may produce transient input currents up to 50 mA, 50 ns maximum pulse width, provided average current does not exceed 20 mA.
3. Device considered a two terminal device: pins 1, 2, 3 and 4 shorted together, and pins 5, 6, 7 and 8 shorted together.
4. The $t_{PLH}$ propagation delay is measured from the 3.75 mA point on the trailing edge of the input pulse to the 1.5 V point on the trailing edge of the output pulse.
5. The $t_{PHL}$ propagation delay is measured from the 3.75 mA point on the leading edge of the input pulse to the 1.5V point on the leading edge of the output pulse.
6. The $t_{ELH}$ enable propagation delay is measured from the 1.5 V point on the trailing edge of the enable input pulse to the 1.5 V point on the trailing edge of the output pulse.
7. The $t_{EHL}$ enable propagation delay is measured from the 1.5 V point on the leading edge of the enable input pulse to the 1.5 V point on the leading edge of the output pulse.
8. $CM_H$ is the maximum tolerable rate of rise of the common mode voltage to assure that the output will remain in a high logic state (i.e., $V_{OUT} > 2.0$ V).
9. $CM_L$ is the maximum tolerable rate of fall of the common mode voltage to assure that the output will remain in a low logic state (i.e., $V_{OUT} < 0.8$ V).
10. For sinusoidal voltages, $\left(\frac{|dv_{CM}|}{dt}\right)_{max} = \pi f_{CM} V_{CM}$ (p-p)
11. No external pull up is required for a high logic state on the enable input.

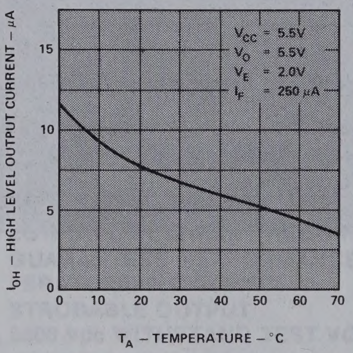


**Figure 2. High Level Output Current vs. Temperature.**

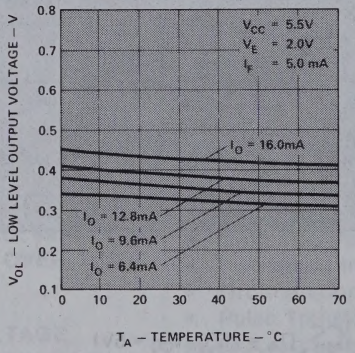


**Figure 3. Low Level Output Voltage vs. Temperature.**

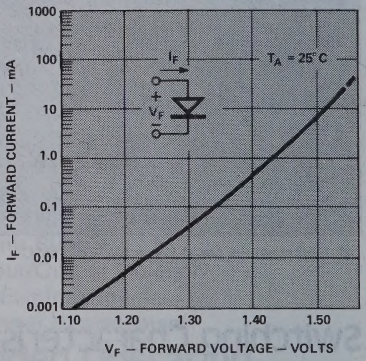


**Figure 4. Input Diode Forward Characteristic.**

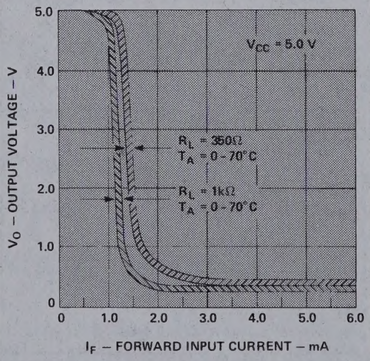
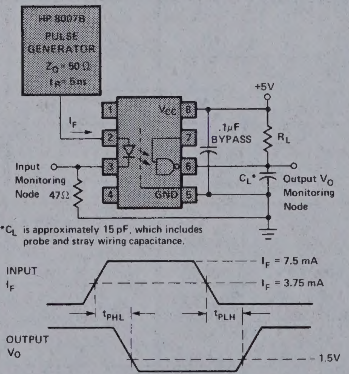


**Figure 5. Output Voltage vs. Forward Input Current.**



*$C_L$ is approximately 15 pF, which includes probe and stray wiring capacitance.

**Figure 6. Test Circuit for $t_{PHL}$ and $t_{PLH}$.**

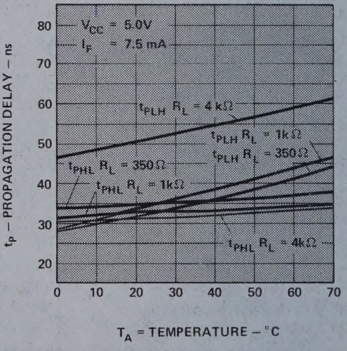


**Figure 7. Propagation Delay vs. Temperature.**

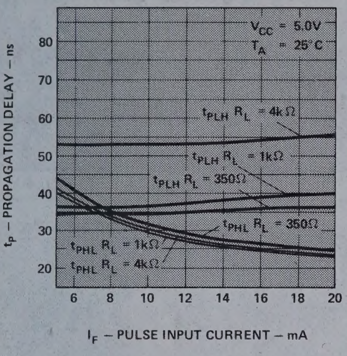
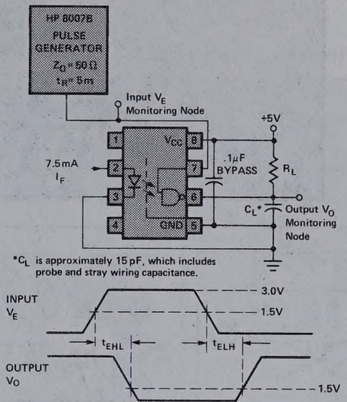


Figure 8. Propagation Delay vs. Pulse Input Current.



HP 8007B PULSE GENERATOR
$Z_O$ = 50 Ω
$t_R$ = 5ns
Input $V_E$ Monitoring Node
+5V
$V_{CC}$
1
2
3
4
5
6
7
8
7.5mA
$I_F$
.1μF BYPASS
$R_L$
GND
$C_L$*
Output $V_O$ Monitoring Node
*$C_L$ is approximately 15 pF, which includes probe and stray wiring capacitance.
INPUT $V_E$
3.0V
1.5V
$t_{EHL}$
$t_{ELH}$
OUTPUT $V_O$
1.5V

Figure 9. Test Circuit for $t_{EHL}$ and $t_{ELH}$.

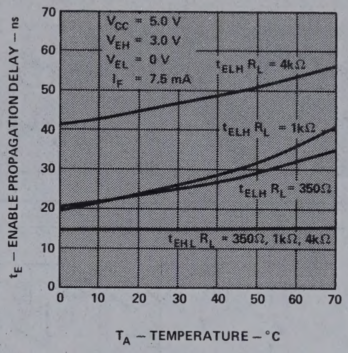


Figure 10. Enable Propagation Delay vs. Temperature.

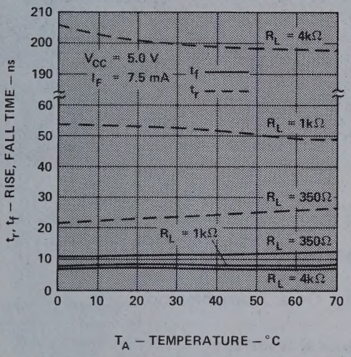
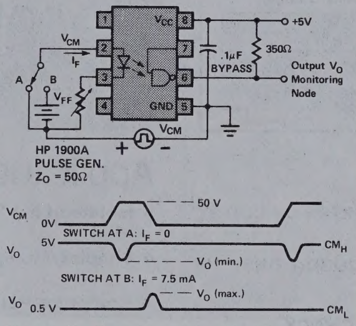


Figure 11. Rise, Fall Time vs. Temperature.



1
2
3
4
5
6
7
8
$V_{CC}$
+5V
$V_{CM}$
$I_F$
A
B
$V_{FF}$
.1μF BYPASS
350Ω
Output $V_O$ Monitoring Node
GND
$V_{CM}$
HP 1900A PULSE GEN.
$Z_O$ = 50Ω
$V_{CM}$
0V
50 V
SWITCH AT A: $I_F$ = 0
5V
$V_O$
$V_O$ (min.)
$CM_H$
SWITCH AT B: $I_F$ = 7.5 mA
$V_O$
0.5 V
$V_O$ (max.)
$CM_L$

Figure 12. Test Circuit for Common Mode Transient Immunity and Typical Waveforms.

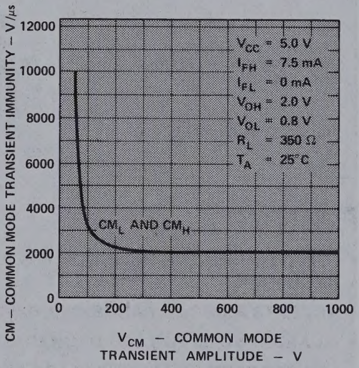


Figure 13. Common Mode Transient Immunity vs. Common Mode Transient Amplitude.

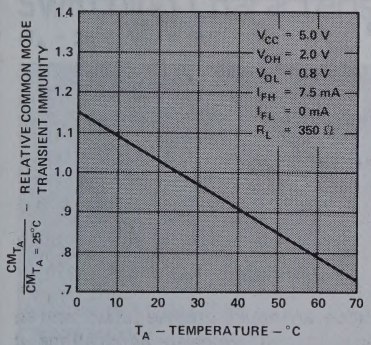
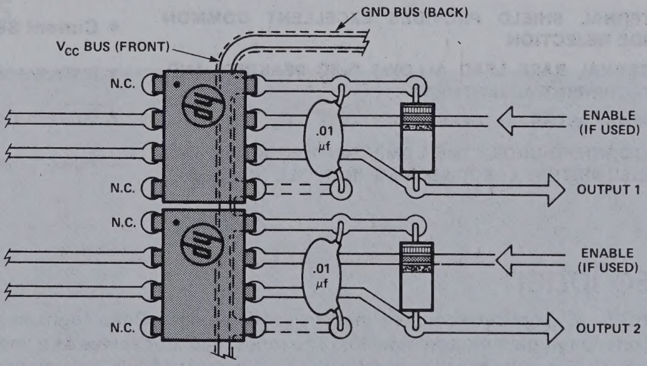


Figure 14. Relative Common Mode Transient Immunity vs. Temperature.



GND BUS (BACK)
$V_{CC}$ BUS (FRONT)
N.C.
N.C.
N.C.
N.C.
.01 μf
.01 μf
ENABLE (IF USED)
OUTPUT 1
ENABLE (IF USED)
OUTPUT 2

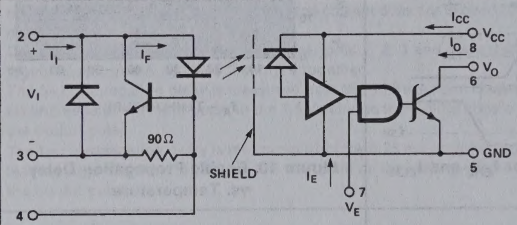
Figure 15. Recommended Printed Circuit Board Layout.

HEWLETT PACKARD

# HIGH CMR LINE RECEIVER OPTOCOUPLER

## HCPL-2602

TECHNICAL DATA FEBRUARY 1982

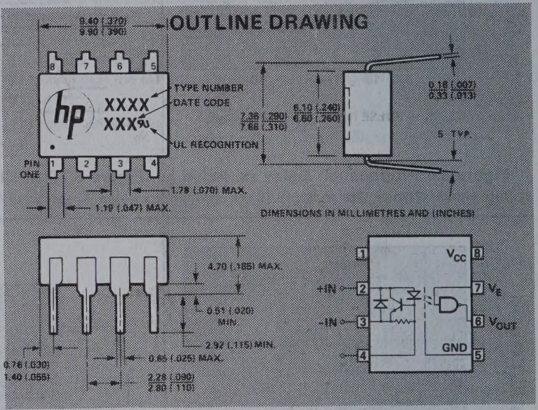

Icc
2
+
I1
IF
VCC 8
IO
VO 6
VI
-
3
90Ω
SHIELD
IE
GND 5
7
VE
4

A 0.01 TO 0.1 μF BYPASS CAPACITOR MUST BE CONNECTED BETWEEN PINS 8 AND 5 (See Note 1).

**TRUTH TABLE**
(Positive Logic)

| Input | Enable | Output |
|---|---|---|
| H | H | L |
| L | H | H |
| H | L | H |
| L | L | H |

**Figure 1. Schematic.**


9.40 (.370)
9.90 (.390)
8
7
6
5
TYPE NUMBER
DATE CODE
UL RECOGNITION
hp
XXXX
XXX
PIN ONE
1
2
3
4
1.78 (.070) MAX.
1.19 (.047) MAX.
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
DIMENSIONS IN MILLIMETRES AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
VCC
+IN
-IN
VE
VOUT
GND

**OUTLINE DRAWING**

## Features

- LINE TERMINATION INCLUDED — NO EXTRA CIRCUITRY REQUIRED
- ACCEPTS A BROAD RANGE OF DRIVE CONDITIONS
- GUARDBANDED FOR LED DEGRADATION
- LED PROTECTION MINIMIZES LED EFFICIENCY DEGRADATION
- HIGH SPEED — 10Mbs (LIMITED BY TRANSMISSION LINE IN MANY APPLICATIONS)
- INTERNAL SHIELD PROVIDES EXCELLENT COMMON MODE REJECTION
- EXTERNAL BASE LEAD ALLOWS “LED PEAKING” AND LED CURRENT ADJUSTMENT
- 3000 Vdc WITHSTAND TEST VOLTAGE
- RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)

## Applications

- Isolated Line Receiver
- Simplex/Multiplex Data Transmission
- Computer-Peripheral Interface
- Microprocessor System Interface
- Digital Isolation for A/D, D/A Conversion
- Current Sensing
- Instrument Input/Output Isolation
- Ground Loop Elimination
- Pulse Transformer Replacement

## Description

The HCPL-2602 optically coupled line receiver combines a GaAsP light emitting diode, an input current regulator and an integrated high gain photon detector. The input regulator serves as a line termination for line receiver applications. It clamps the line voltage and regulates the LED current so line reflections do not interfere with circuit performance.

The regulator allows a typical LED current of 8.5 mA before it starts to shunt excess current. The output of the detector IC is an open collector Schottky clamped transistor. An enable input gates the detector. The internal detector shield provides a guaranteed common mode transient immunity specification of 1000V/μsec, equivalent to rejecting a 300V P-P sinusoid at 1 MHz.

DC specifications are defined similar to TTL logic and are guaranteed from 0° C to 70° C allowing trouble free interfacing with digital logic circuits. An input current of 5 mA will sink an eight gate fan-out (TTL) at the output with a typical propagation delay from input to output of only 45 nsec.

The HCPL-2602's are useful as line receivers in high noise environments that conventional line receivers cannot tolerate. The higher LED threshold voltage provides improved immunity to differential noise and the internally shielded detector provides orders of magnitude improvement in common mode rejection with little or no sacrifice in speed.

# Electrical Characteristics

(Over Recommended Temperature, $T_A$ = 0° C to +70° C, Unless Otherwise Noted)

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| High Level Output Current | $I_{OH}$ | | 7 | 250 | μA | $V_{CC}$ = 5.5V, $V_O$ = 5.5V<br>$I_I$=250 μA, $V_E$=2.0V | 4 | |
| Low Level Output Voltage | $V_{OL}$ | | 0.4 | 0.6 | V | $V_{CC}$=5.5V, $I_I$=5 mA<br>$V_E$=2.0V,<br>$I_{OL}$ (Sinking)=13 mA | 2,5 | 2 |
| Input Voltage | $V_I$ | | 2.0 | 2.4 | V | $I_I$=5 mA | 3 | |
| | | | 2.3 | 2.7 | | $I_I$=60 mA | 3 | |
| Input Reverse Voltage | $V_R$ | | 0.75 | 0.95 | V | $I_R$=5 mA | | |
| Low Level Enable Current | $I_{EL}$ | | -1.6 | -2.0 | mA | $V_{CC}$=5.5V, $V_E$=0.5V | | |
| High Level Enable Current | $I_{EH}$ | | -1.0 | | mA | $V_{CC}$=5.5V, $V_E$=2.0V | | |
| High Level Enable Voltage | $V_{EH}$ | 2.0 | | | V | | | 11 |
| Low Level Enable Voltage | $V_{EL}$ | | | 0.8 | V | | | |
| High Level Supply Current | $I_{CCH}$ | | 10 | 15 | mA | $V_{CC}$=5.5V, $I_I$=0,<br>$V_E$=0.5V | | |
| Low Level Supply Current | $I_{CCL}$ | | 16 | 19 | mA | $V_{CC}$=5.5V, $I_I$=60 mA<br>$V_E$=0.5V | | |
| Input Capacitance | $C_{IN}$ | | 90 | | pF | $V_I$=0, f=1 MHz,<br>(PIN 2-3) | | |
| Input-Output Insulation Leakage Current | $I_{I-O}$ | | | 1 | μA | Relative Humidity=45%<br>$T_A$=25° C, t=5 s,<br>$V_{I-O}$=3000 Vdc | | 3 |
| Resistance (Input-Output) | $R_{I-O}$ | | $10^{12}$ | | Ω | $V_{I-O}$=500V | | 3 |
| Capacitance (Input-Output) | $C_{I-O}$ | | 0.6 | | pF | f = 1 MHz | | 3 |

*All typical values are at $V_{CC}$ = 5V, $T_A$ = 25°C.

# Switching Characteristics

($T_A$ = 25°C, $V_{CC}$ = 5V)

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to High Output Level | $t_{PLH}$ | | 45 | 75 | ns | $R_L$ = 350 Ω<br>$C_L$ = 15 pF<br>$I_I$ = 7.5 mA | 6 | 4 |
| Propagation Delay Time to Low Output Level | $t_{PHL}$ | | 45 | 75 | ns | | 6 | 5 |
| Output Rise Time (10-90%) | $t_r$ | | 25 | | ns | | | |
| Output Fall Time (90-10%) | $t_f$ | | 15 | | ns | | | |
| Propagation Delay Time of Enable from $V_{EH}$ to $V_{EL}$ | $t_{ELH}$ | | 25 | | ns | $R_L$=350Ω, $C_L$=15 pF,<br>$I_I$=7.5 mA, $V_{EH}$=3 V,<br>$V_{EL}$=0 V | 10 | 6 |
| Propagation Delay Time of Enable from $V_{EL}$ to $V_{EH}$ | $t_{EHL}$ | | 15 | | ns | | 10 | 7 |
| Common Mode Transient Immunity at High Output Level | $CM_H$ | 1000 | 10,000 | | V/μs | $V_{CM}$=50 V (peak),<br>$V_O$ (min.)=2 V,<br>$R_L$=350Ω, $I_I$=0 mA | 12 | 8 |
| Common Mode Transient Immunity at Low Output Level | $CM_L$ | -1000 | -10,000 | | V/μs | $V_{CM}$=50 V (peak),<br>$V_O$ (max.)=0.8 V,<br>$R_L$=350Ω, $I_I$=7.5 mA | 12 | 9 |

# Using the HCPL-2602 Line Receiver Optocoupler

The primary objectives to fulfill when connecting an optocoupler to a transmission line are to provide a minimum, but not excessive, LED current and to properly terminate the line. The internal regulator in the HCPL-2602 simplifies this task. Excess current from variable drive conditions such as line length variations, line driver differences and power supply fluctuations are shunted by the regulator. In fact, with the LED current regulated, the line current can be increased to improve the immunity of the system to differential-mode-noise and to enhance the data rate capability. The designer must keep in mind the 60 mA input current maximum rating of the HCPL-2602, in such cases, and may need to use series limiting or shunting to prevent overstress.

Design of the termination circuit is also simplified; in most cases the transmission line can simply be connected directly to the input terminals of the HCPL-2602 without the need for additional series or shunt resistors. If reversing line drive is used it may be desirable to use two HCPL-2602's, or an external Schottky diode to optimize data rate.

## Polarity Non-Reversing Drive

High data rates can be obtained with the HCPL-2602 with polarity non-reversing drive. Figure (a) illustrates how a 74S140 line driver can be used with the HCPL-2602 and shielded, twisted pair or coax cable without any additional components. There are some reflections due to the "active termination" but they do not interfere with circuit performance because the regulator clamps the line voltage. At longer line lengths $t_{PLH}$ increases faster than $t_{PHL}$ since the switching threshold is not exactly halfway between asymptotic line conditions. If optimum data rate is desired, a series resistor and peaking capacitor can be used to equalize $t_{PLH}$ and $t_{PHL}$. In general, the peaking capacitance should be as large as possible; however, if it is too large it may keep the regulator from achieving turn-off during the negative (or zero) excursions of the input signal. A safe rule:

make $C \leqslant 16t$
where $C$ = peaking capacitance in picofarads
$t$ = data bit interval in nanoseconds

## Polarity Reversing Drive

A single HCPL-2602 can also be used with polarity reversing drive (Figure b). Current reversal is obtained by way of the substrate isolation diode (substrate to collector). Some reduction of data rate occurs, however, because the substrate diode stores charge, which must be removed when the current changes to the forward direction. The effect of this is a longer $t_{PHL}$. This effect can be eliminated and data rate improved considerably by use of a Schottky diode on the input of the HCPL-2602.

For optimum noise rejection as well as balanced delays a split-phase termination should be used along with a flip-flop at the output (Figure c). The result of current reversal in split-phase operation is seen in Figure (c) with switches A and B both OPEN. The coupler inputs are then connected in ANTI-SERIES; however, because of the higher steady-state termination voltage, in comparison to the single HCPL-2602 termination, the forward current in the substrate diode is lower and consequently there is less junction charge to deal with when switching.

Closing switch B with A open is done mainly to enhance common mode rejection, but also reduces propagation delay slightly because line-to-line capacitance offers a slight peaking effect. With switches A and B both CLOSED, the shield acts as a current return path which prevents either input substrate diode from becoming reversed biased. Thus the data rate is optimized as shown in Figure (c).

## Improved Noise Rejection

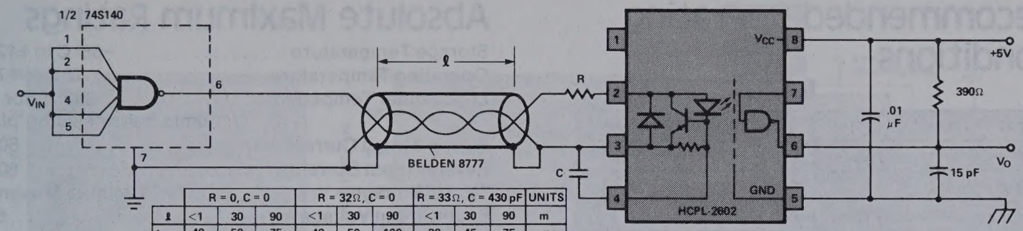
Use of additional logic at the output of two HCPL-2602's operated in the split phase termination, will greatly improve system noise rejection in addition to balancing propagation delays as discussed earlier.

A NAND flip-flop offers infinite common mode rejection (CMR) for NEGATIVELY sloped common mode transients but requires $t_{PHL} > t_{PLH}$ for proper operation. A NOR flip-flop has infinite CMR for POSITIVELY sloped transients but requires $t_{PHL} < t_{PLH}$ for proper operation. An exclusive-OR flip-flop has infinite CMR for common mode transients of EITHER polarity and operates with either $t_{PHL} > t_{PLH}$ or $t_{PHL} < t_{PLH}$.

With the line driver and transmission line shown in Figure (c), $t_{PHL} > t_{PLH}$, so NAND gates are preferred in the R-S flip-flop. A higher drive amplitude or different circuit configuration could make $t_{PHL} < t_{PLH}$, in which case NOR gates would be preferred. If it is not known whether $t_{PHL} > t_{PLH}$ or $t_{PHL} < t_{PLH}$, or if the drive conditions may vary over the boundary for these conditions, the exclusive-OR flip-flop of Figure (d) should be used.

## RS-422 and RS-423

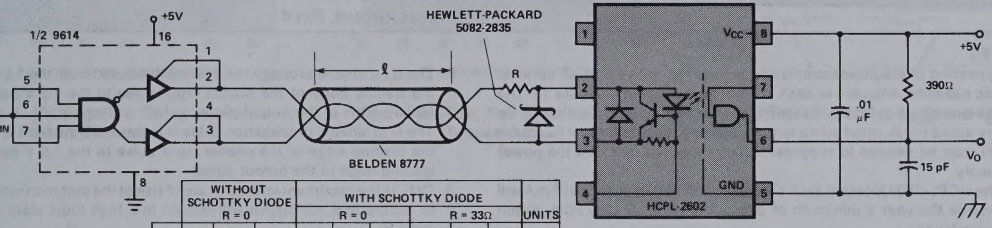
Line drivers designed for RS-422 and RS-423 generally provide adequate voltage and current for operating the HCPL-2602. Most drivers also have characteristics allowing the HCPL-2602 to be connected directly to the driver terminals. Worst case drive conditions, however, would require current shunting to prevent overstress of the HCPL-2602.


1/2 74S140
1
2
4
5
6
7
VIN
ℓ
BELDEN 8777
R
C
HCPL-2602
VCC
GND
8
7
6
5
1
2
3
4
+5V
.01 µF
390Ω
15 pF
VO

| ℓ | R = 0, C = 0 | | | R = 32Ω, C = 0 | | | R = 33Ω, C = 430 pF | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|
| ℓ | <1 | 30 | 90 | <1 | 30 | 90 | <1 | 30 | 90 | m |
| $t_{PHL}$ | 40 | 50 | 75 | 40 | 50 | 100 | 30 | 45 | 75 | nsec |
| $t_{PLH}$ | 45 | 65 | 175 | 40 | 50 | 80 | 40 | 45 | 75 | nsec |

PROPAGATION TIMES SHOWN EXCLUDE DRIVER AND LINE DELAYS.

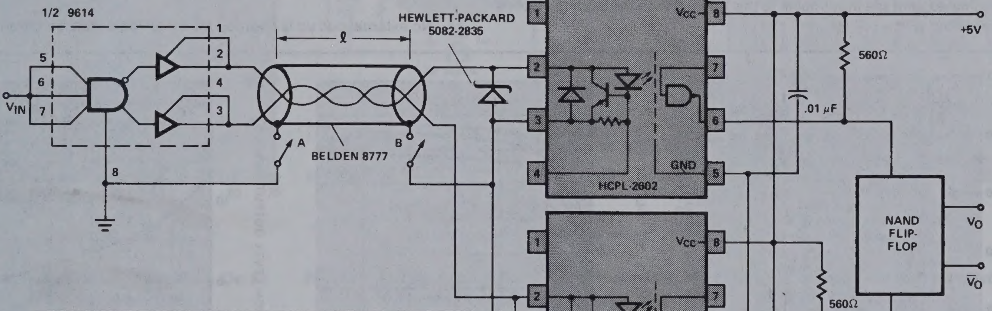
**Figure a. Polarity Non-Reversing.**


+5V
16
1/2 9614
1
2
5
6
4
7
3
VIN
8
ℓ
BELDEN 8777
HEWLETT-PACKARD
5082-2835
R
HCPL-2602
VCC
GND
+5V
.01 µF
390Ω
15 pF
VO

| | WITHOUT SCHOTTKY DIODE | | | WITH SCHOTTKY DIODE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R = 0 | | | R = 0 | | | R = 33Ω | | | UNITS |
| ℓ | <1 | 30 | 90 | <1 | 30 | 90 | <1 | 30 | 90 | m |
| $t_{PHL}$ | 210 | 365 | 450 | 50 | 80 | 235 | 50 | 70 | 200 | nsec |
| $t_{PLH}$ | 35 | 45 | 60 | 35 | 45 | 60 | 35 | 45 | 60 | nsec |

PROPAGATION TIMES SHOWN EXCLUDE DRIVER AND LINE DELAYS.

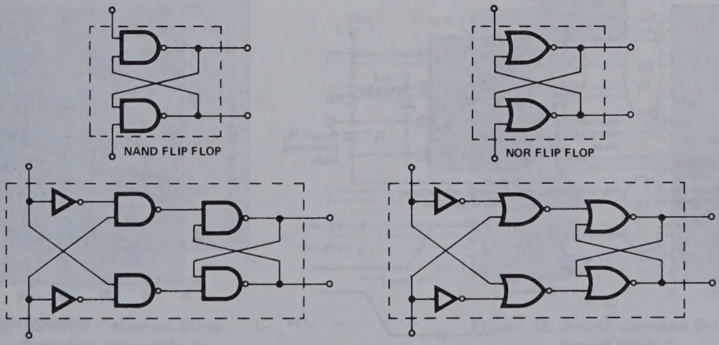
**Figure b. Polarity Reversing, Single Ended.**


1/2 9614
1
2
5
6
4
7
3
VIN
8
ℓ
A
B
BELDEN 8777
HEWLETT-PACKARD
5082-2835
HCPL-2602
HCPL-2602
VCC
GND
+5V
560Ω
560Ω
.01 µF
.01 µF
NAND FLIP-FLOP
VO
V̄O

| | WITHOUT SCHOTTKY DIODES | | | WITH SCHOTTKY DIODES | | | SWITCH A | SWITCH B | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| ℓ | <1 | 30 | 90 | <1 | 30 | 90 | – | – | m |
| $t_p$ | 100 | 165 | 340 | 55 | 75 | 215 | OPEN | OPEN | nsec |
| | 45 | 125 | 310 | 45 | 70 | 185 | OPEN | CLOSED | nsec |
| | 45 | 60 | 125 | 45 | 60 | 125 | CLOSED | CLOSED | nsec |

PROPAGATION TIMES SHOWN EXCLUDE DRIVER AND LINE DELAYS.

**Figure c. Polarity Reversing, Split Phase.**


NAND FLIP FLOP
NOR FLIP FLOP
EXCLUSIVE–OR FLIP FLOP

NAND flip flop tolerates simultaneously HIGH inputs; NOR flip flop tolerates simultaneously LOW inputs; EXCLUSIVE-OR flip flop tolerates simultaneously HIGH OR LOW inputs without causing either of the outputs to change.

**Figure d. Flip Flop Configurations.**

# Recommended Operating Conditions

| | Sym. | Min. | Max. | Units |
|---|---|---|---|---|
| Input Current, Low Level | $I_{IL}$ | 0 | 250 | μA |
| Input Current, High Level | $I_{IH}$ | 5 | 60 | mA |
| Supply Voltage, Output | $V_{CC}$ | 4.5 | 5.5 | V |
| High Level Enable Voltage | $V_{EH}$ | 2.0 | $V_{CC}$ | V |
| Low Level Enable Voltage | $V_{EL}$ | 0 | 0.8 | V |
| Fan Out (TTL Load) | N | | 8 | |
| Operating Temperature | $T_A$ | 0 | 70 | °C |

# Absolute Maximum Ratings

Storage Temperature .............. −55° C to +125° C
Operating Temperature ................ 0° C to +70° C
Lead Solder Temperature ........... 260° C for 10 s
(1.6mm below seating plane)
Forward Input Current — $I_I$ .................... 60 mA
Reverse Input Current ....................... 60 mA
Supply Voltage – $V_{CC}$ ......... 7V (1 Minute Maximum)
Enable Input Voltage – $V_E$ ...................... 5.5 V
(Not to exceed $V_{CC}$ by more than 500 mV)
Output Collector Current – $I_O$ ................. 25 mA
Output Collector Power Dissipation ............. 40 mW
Output Collector Voltage – $V_O$ .................... 7 V
Input Current, Pin 4 ............................ ±10 mA

NOTES:

1. Bypassing of the power supply line is required, with a 0.01 μF ceramic disc capacitor adjacent to each isolator as illustrated in Figure 15. The power supply bus for the isolator(s) should be separate from the bus for any active loads, otherwise a larger value of bypass capacitor (up to 0.1 μF) may be needed to suppress regenerative feedback via the power supply.
2. The HCPL-2602 is tested such that operation at $I_I$ minimum of 5 mA will provide the user a minimum of 20% guardband for LED light output degradation.
3. Device considered a two terminal device: pins 1, 2, 3 and 4 shorted together, and pins 5, 6, 7 and 8 shorted together.
4. The $t_{PLH}$ propagation delay is measured from the 3.75 mA point on the trailing edge of the input pulse to the 1.5 V point on the trailing edge of the output pulse.
5. The $t_{PHL}$ propagation delay is measured from the 3.75 mA point on the leading edge of the input pulse to the 1.5V point on the leading edge of the output pulse.
6. The $t_{ELH}$ enable propagation delay is measured from the 1.5 V point on the trailing edge of the enable input pulse to the 1.5 V point on the trailing edge of the output pulse.
7. The $t_{EHL}$ enable propagation delay is measured from the 1.5 V point on the leading edge of the enable input pulse to the 1.5 V point on the leading edge of the output pulse.
8. $CM_H$ is the maximum tolerable rate of rise of the common mode voltage to assure that the output will remain in a high logic state (i.e., $V_{OUT} > 2.0$ V).
9. $CM_L$ is the maximum tolerable rate of fall of the common mode voltage to assure that the output will remain in a low logic state (i.e., $V_{OUT} < 0.8$ V).
10. For sinusoidal voltages, $\left(\frac{|dv_{CM}|}{dt}\right)_{max} = \pi f_{CM} V_{CM}$ (p-p)
11. No external pull up is required for a high logic state on the enable input.

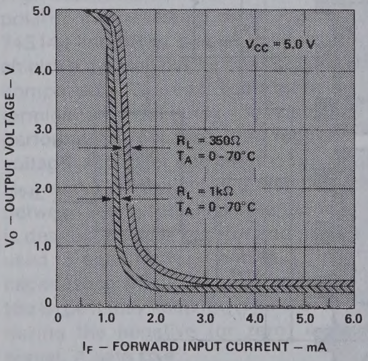


**Figure 2. Output Voltage vs. Forward Input Current.**

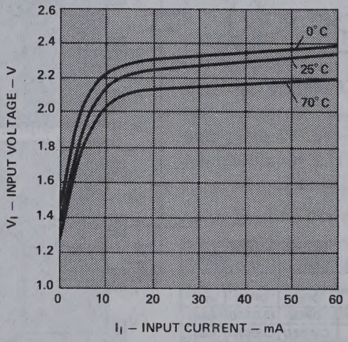


**Figure 3. Input Characteristics.**

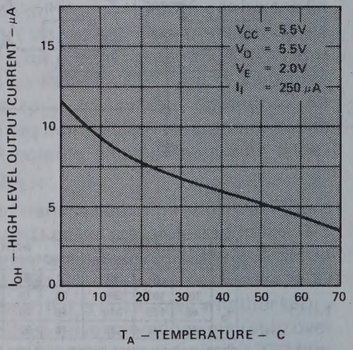


**Figure 4. High Level Output Current vs. Temperature.**

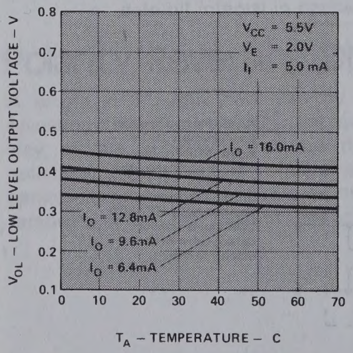


**Figure 5. Low Level Output Voltage vs. Temperature.**

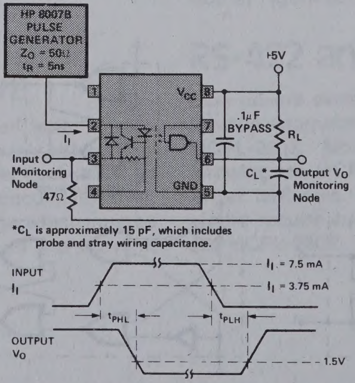


**Figure 6. Test Circuit for $t_{PHL}$ and $t_{PLH}$.**

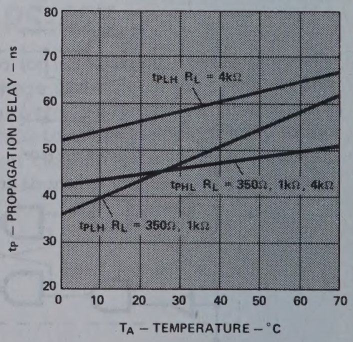


**Figure 7. Propagation Delay vs. Temperature.**

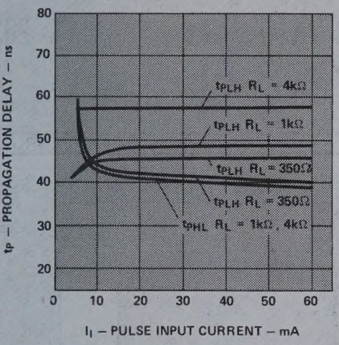


Figure 8. Propagation Delay vs. Pulse Input Current.

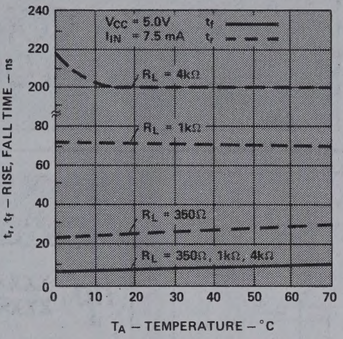


Figure 9. Rise, Fall Time vs. Temperature.

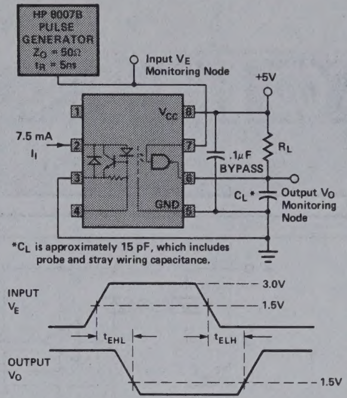

HP 8007B
PULSE
GENERATOR
ZO = 50Ω
tR = 5ns
Input VE
Monitoring Node
+5V
1
2
3
4
8
7
6
5
VCC
GND
7.5 mA
II
.1μF
BYPASS
RL
CL *
Output VO
Monitoring
Node
*CL is approximately 15 pF, which includes probe and stray wiring capacitance.
INPUT
VE
3.0V
1.5V
tEHL
tELH
OUTPUT
VO
1.5V

Figure 10. Test Circuit for $t_{EHL}$ and $t_{ELH}$.

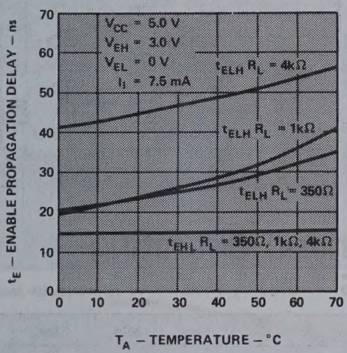


Figure 11. Enable Propagation Delay vs. Temperature.

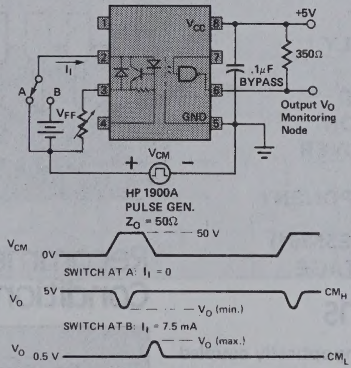

1
2
3
4
8
7
6
5
VCC
GND
+5V
350Ω
.1μF
BYPASS
Output VO
Monitoring
Node
II
A
B
VFF
VCM
+
–
HP 1900A
PULSE GEN.
ZO = 50Ω
VCM
0V
50 V
SWITCH AT A: II = 0
5V
VO
CMH
VO (min.)
SWITCH AT B: II = 7.5 mA
VO
0.5 V
VO (max.)
CML

Figure 12. Test Circuit for Common Mode Transient Immunity and Typical Waveforms.

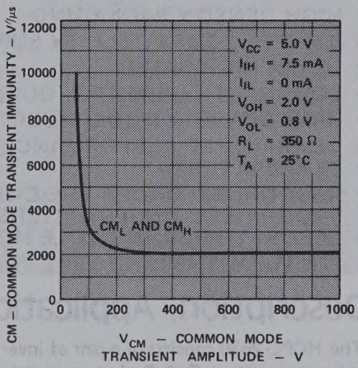


Figure 13. Common Mode Transient Immunity vs. Common Mode Transient Amplitude.

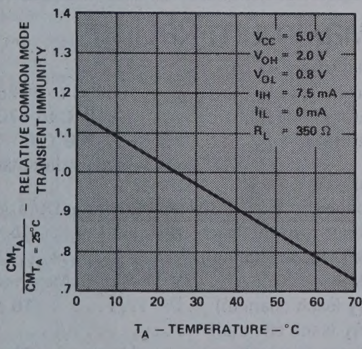


Figure 14. Relative Common Mode Transient Immunity vs. Temperature.

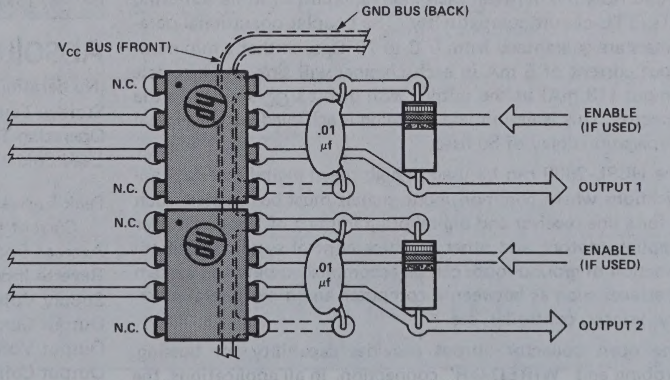

GND BUS (BACK)
VCC BUS (FRONT)
N.C.
N.C.
N.C.
N.C.
.01 μf
.01 μf
ENABLE (IF USED)
OUTPUT 1
ENABLE (IF USED)
OUTPUT 2

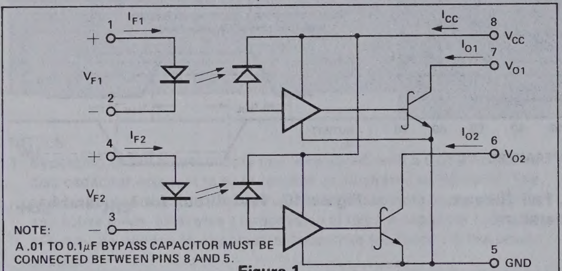
Figure 15. Recommended Printed Circuit Board Layout.

**HEWLETT PACKARD**

# DUAL TTL COMPATIBLE OPTOCOUPLER

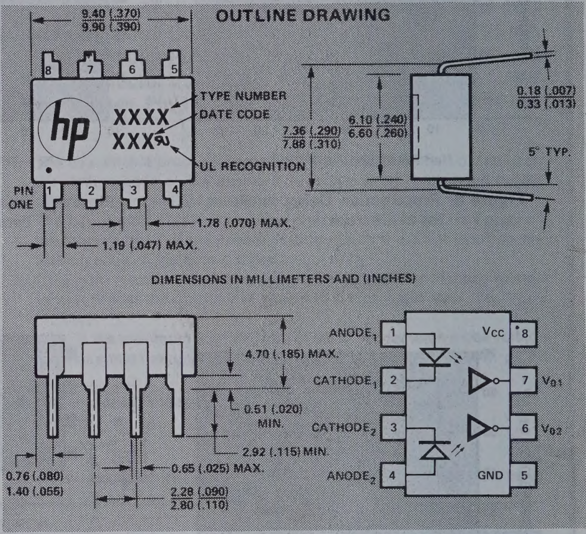
## HCPL-2630

TECHNICAL DATA FEBRUARY 1982


1
$I_{F1}$
+
$V_{F1}$
2
−
4
$I_{F2}$
+
$V_{F2}$
3
−
$I_{CC}$
8
$V_{CC}$
$I_{O1}$
7
$V_{O1}$
$I_{O2}$
6
$V_{O2}$
5
GND

NOTE:
A .01 TO 0.1µF BYPASS CAPACITOR MUST BE CONNECTED BETWEEN PINS 8 AND 5.

Figure 1.


OUTLINE DRAWING
9.40 (.370)
9.90 (.390)
8
7
6
5
hp
XXXX
XXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
PIN ONE
1
2
3
4
1.78 (.070) MAX.
1.19 (.047) MAX.
DIMENSIONS IN MILLIMETERS AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
ANODE₁ 1
CATHODE₁ 2
CATHODE₂ 3
ANODE₂ 4
Vcc 8
7 $V_{O1}$
6 $V_{O2}$
GND 5

## Features

- HIGH DENSITY PACKAGING
- DTL/TTL COMPATIBLE: 5V SUPPLY
- ULTRA HIGH SPEED
- LOW INPUT CURRENT REQUIRED
- HIGH COMMON MODE REJECTION
- GUARANTEED PERFORMANCE OVER TEMPERATURE
- RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)
- 3000Vdc WITHSTAND TEST VOLTAGE

## Description/Applications

The HCPL-2630 consists of a pair of inverting optically coupled gates each with a GaAsP photon emitting diode and a unique integrated detector. The photons are collected in the detector by a photodiode and then amplified by a high gain linear amplifier that drives a Schottky clamped open collector output transistor. Each circuit is temperature, current and voltage compensated.

This unique dual coupler design provides maximum DC and AC circuit isolation between each input and output while achieving DTL/TTL circuit compatibility. The coupler operational parameters are guaranteed from 0°C to 70°C, such that a minimum input current of 5 mA in each channel will sink an eight gate fan-out (13 mA) at the output with 5 volt $V_{CC}$ applied to the detector. This isolation and coupling is achieved with a typical propagation delay of 50 nsec.

The HCPL-2630 can be used in high speed digital interface applications where common mode signals must be rejected such as for a line receiver and digital programming of floating power supplies, motors, and other machine control systems. The elimination of ground loops can be accomplished between system interfaces such as between a computer and a peripheral memory, printer, controller, etc.

The open collector output provides capability for bussing, strobing and "WIRED-OR" connection. In all applications, the dual channel configuration allows for high density packaging, increased convenience and more usable board space.

## Recommended Operating Conditions

| | Sym. | Min. | Max. | Units |
|---|---|---|---|---|
| Input Current, Low Level Each Channel | $I_{FL}$ | 0 | 250 | µA |
| Input Current, High Level Each Channel | $I_{FH}$ | 6.3* | 15 | mA |
| Supply Voltage, Output | $V_{CC}$ | 4.5 | 5.5 | V |
| Fan Out (TTL Load) Each Channel | N | | 8 | |
| Operating Temperature | $T_A$ | 0 | 70 | °C |

## Absolute Maximum Ratings

(No derating required up to 70°C)

Storage Temperature . . . . . . . . . . . . . . . . -55°C to +125°C
Operating Temperature . . . . . . . . . . . . . . . . . 0°C to +70°C
Lead Solder Temperature . . . . . . . . . . . . . . . . 260°C for 10s
(1.6mm below seating plane)
Peak Forward Input
Current (each channel) . . . . . 30 mA (≤1 msec Duration)
Average Forward Input Current (each channel) . . . . . 15 mA
Reverse Input Voltage (each channel) . . . . . . . . . . . . . . . . 5V
Supply Voltage – $V_{CC}$ . . . . . . . . . . 7V (1 Minute Maximum)
Output Current – $I_O$ (each channel) . . . . . . . . . . . . . 16 mA
Output Voltage – $V_O$ (each channel) . . . . . . . . . . . . . . . 7V
Output Collector Power Dissipation . . . . . . . . . . . . . 60 mW

*6.3mA condition permits at least 20% CTR degradation guardband. Initial switching threshold is 5mA or less.

# Electrical Characteristics

## OVER RECOMMENDED TEMPERATURE ($T_A$ = 0°C TO 70°C) UNLESS OTHERWISE NOTED

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| High Level Output Current | $I_{OH}$ | | 50 | 250 | µA | $V_{CC} = 5.5V$, $V_O = 5.5V$, $I_F = 250\mu A$ | | 3 |
| Low Level Output Voltage | $V_{OL}$ | | 0.5 | 0.6 | V | $V_{CC} = 5.5V$, $I_F = 5mA$<br>$I_{OL}$ (Sinking) = 13mA | 3 | 3 |
| High Level Supply Current | $I_{CCH}$ | | 14 | 30 | mA | $V_{CC} = 5.5V$, $I_F = 0$ (Both Channels) | | |
| Low Level Supply | $I_{CCL}$ | | 26 | 36 | mA | $V_{CC} = 5.5V$, $I_F = 10mA$ (Both Channels) | | |
| Input – Output Insulation Leakage Current | $I_{I-O}$ | | | 1.0 | µA | Relative Humidity = 45%<br>$T_A = 25°C$, $t = 5s$,<br>$V_{I-O} = 3000Vdc$ | | 4 |
| Resistance (Input-Output) | $R_{I-O}$ | | $10^{12}$ | | Ω | $V_{I-O} = 500V$, $T_A = 25°C$ | | 4 |
| Capacitance (Input-Output) | $C_{I-O}$ | | 0.6 | | pF | $f = 1MHz$, $T_A = 25°C$ | | 4 |
| Input Forward Voltage | $V_F$ | | 1.5 | 1.75 | V | $I_F = 10mA$, $T_A = 25°C$ | 4 | 7,3 |
| Input Reverse Breakdown Voltage | $BV_R$ | 5 | | | V | $I_R = 10\mu A$, $T_A = 25°C$ | | |
| Input Capacitance | $C_{IN}$ | | 60 | | pF | $V_F = 0$, $f = 1MHz$ | | 3 |
| Input-Input Insulation Leakage Current | $I_{I-I}$ | | 0.005 | | µA | Relative Humidity = 45%, $t$=5s, $V_{I-I}$=500V | | 8 |
| Resistance (Input-Input) | $R_{I-I}$ | | $10^{11}$ | | Ω | $V_{I-I} = 500V$ | | 8 |
| Capacitance (Input-Input) | $C_{I-I}$ | | 0.25 | | pF | $f = 1MHz$ | | 8 |
| Current Transfer Ratio | CTR | | 700 | | % | $I_F = 5.0mA$, $R_L = 100\Omega$ | 2 | 6 |

*All typical values are at $V_{CC} = 5V$, $T_A = 25°C$

# Switching Characteristics at $T_A$=25°C, $V_{CC}$=5V

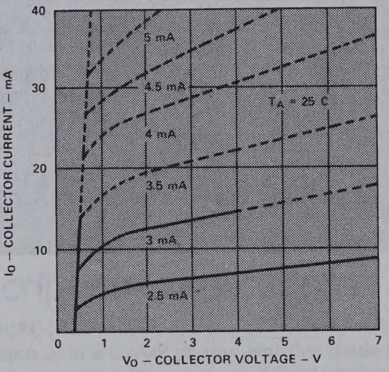
## ACH CHANNEL

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to High Output Level | $t_{PLH}$ | | 55 | 75 | ns | $R_L = 350\ \Omega$, $C_L = 15pF$, $I_F = 7.5mA$ | 6,7 | 1 |
| Propagation Delay Time to Low Output Level | $t_{PHL}$ | | 40 | 75 | ns | $R_L = 350\ \Omega$, $C_L = 15pF$, $I_F = 7.5mA$ | 6,7 | 2 |
| Output Rise-Fall Time (10-90%) | $t_r$, $t_f$ | | 25 | | ns | $R_L = 350\ \Omega$, $C_L = 15pF$, $I_F = 7.5mA$ | | |
| Common Mode Transient Immunity at High Output Level | $CM_H$ | | 50 | | V/µs | $V_{CM} = 10V_{p-p}$,<br>$R_L = 350\ \Omega$,<br>$V_O$ (min.) = 2V, $I_F$ = 0mA | 9 | 5 |
| Common Mode Transient Immunity at Low Output Level | $CM_L$ | | -150 | | V/µs | $V_{CM} = 10V_{p-p}$,<br>$R_L = 350\ \Omega$,<br>$V_O$ (max.) = 0.8V<br>$I_F$ = 7.5mA | 9 | 5 |

**NOTE:** It is essential that a bypass capacitor (.01µF to 0.1µF, ceramic) be connected from pin 8 to pin 5. Total lead length between both ends of the capacitor and the isolator pins should not exceed 20mm. Failure to provide the bypass may impair the switching properties (Figure 5).

**NOTES:**

1. The $t_{PLH}$ propagation delay is measured from the 3.75 mA point on the trailing edge of the input pulse to the 1.5V point on the trailing edge of the output pulse.
2. The $t_{PHL}$ propagation delay is measured from the 3.75 mA point on the leading edge of the input pulse to the 1.5V point on the leading edge of the output pulse.
3. Each channel.
4. Measured between pins 1, 2, 3, and 4 shorted together, and pins 5, 6, 7, and 8 shorted together.
5. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the leading edge of the common mode pulse, $V_{CM}$, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM}/dt$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$).
6. DC Current Transfer Ratio is defined as the ratio of the output collector current to the forward bias input current times 100%.
7. At 10mA VF decreases with increasing temperature at the rate of 1.6mV/°C.
8. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.



NOTE: Dashed characteristics indicate pulsed operation.

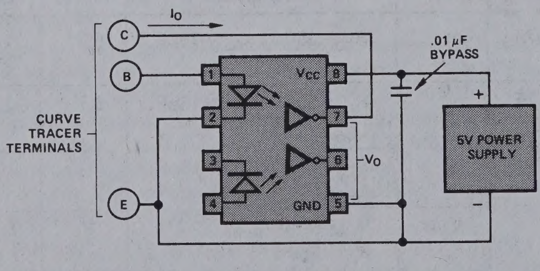


Figure 2. Optocoupler Transfer Characteristics.

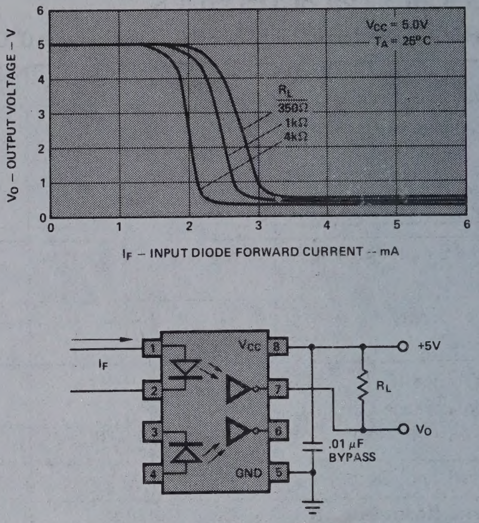


Figure 3. Input-Output Characteristics.

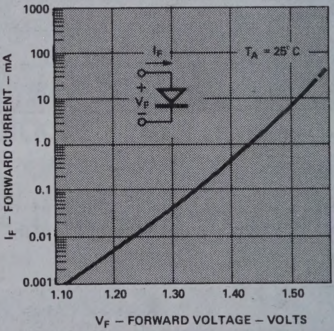


Figure 4. Input Diode Forward Characteristic

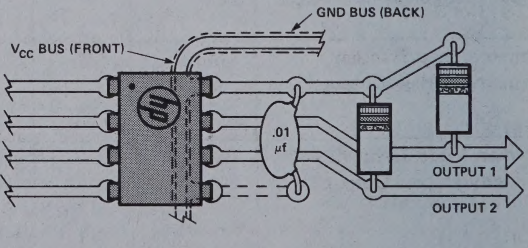
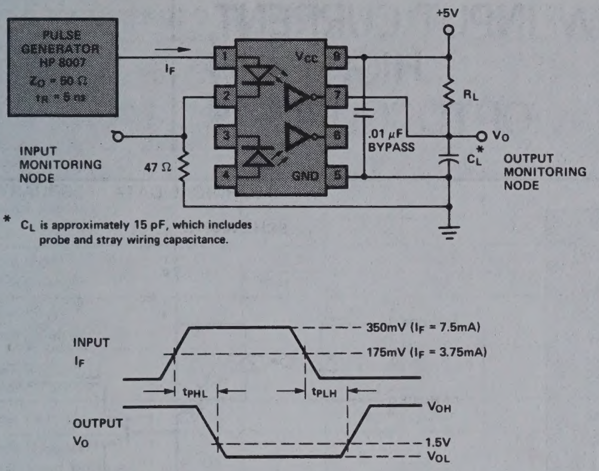


Figure 5. Recommended Printed Circuit Board Layout.


PULSE GENERATOR HP 8007
$Z_O$ = 50 Ω
$t_R$ = 5 ns
$I_F$
INPUT MONITORING NODE
47 Ω
+5V
VCC
GND
1
2
3
4
5
6
7
8
$R_L$
.01 μF BYPASS
$V_O$
$C_L$*
OUTPUT MONITORING NODE
INPUT
$I_F$
OUTPUT
$V_O$
350mV ($I_F$ = 7.5mA)
175mV ($I_F$ = 3.75mA)
$t_{PHL}$
$t_{PLH}$
$V_{OH}$
1.5V
$V_{OL}$

* $C_L$ is approximately 15 pF, which includes probe and stray wiring capacitance.

Figure 6. Test Circuit for $t_{PHL}$ and $t_{PLH}$.

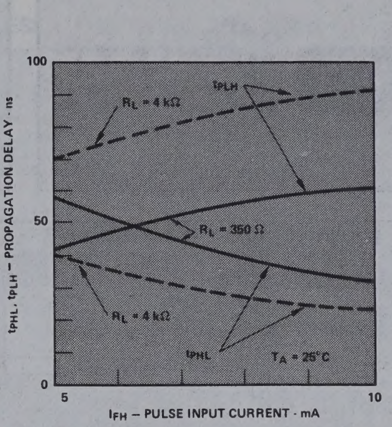


Figure 7. Propagation Delay, $t_{PHL}$ and $t_{PLH}$ vs. Pulse Input Current, $I_{FH}$.

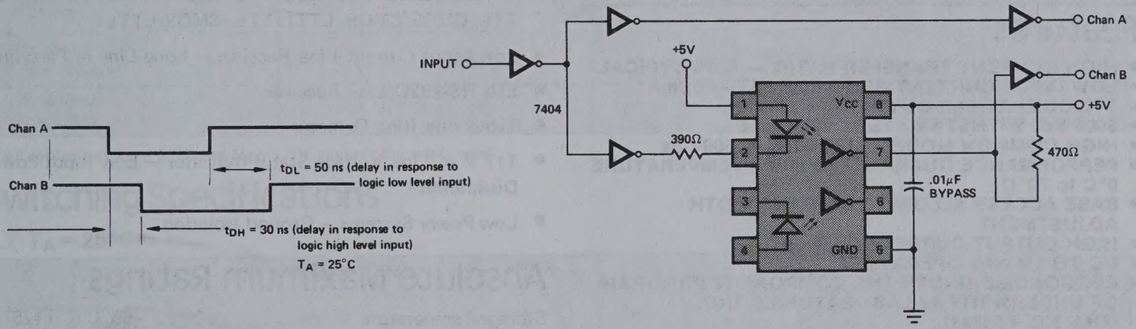

INPUT
7404
Chan A
Chan B
+5V
390Ω
470Ω
.01μF BYPASS
VCC
GND
1
2
3
4
5
6
7
8
Chan A
Chan B
$t_{DL}$ = 50 ns (delay in response to logic low level input)
$t_{DH}$ = 30 ns (delay in response to logic high level input)
$T_A$ = 25°C

Figure 8. Response Delay Between TTL Gates.

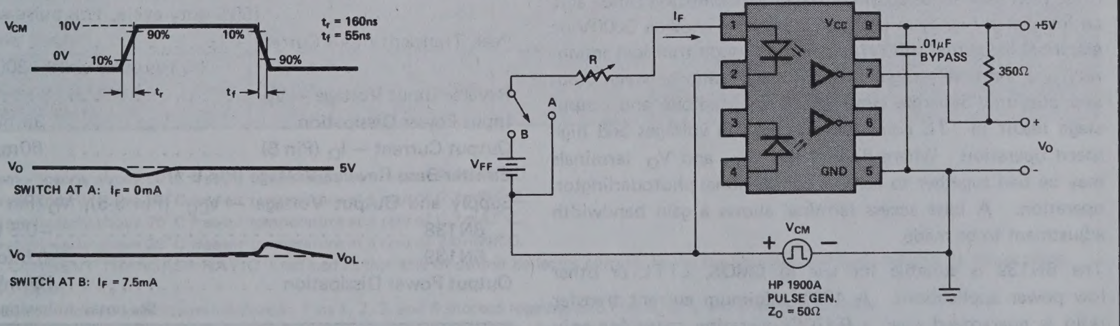

$V_{CM}$
10V
0V
90%
10%
10%
90%
$t_r$
$t_f$
$t_r$ = 160ns
$t_f$ = 55ns
$V_O$
5V
SWITCH AT A: $I_F$ = 0mA
$V_O$
$V_{OL}$
SWITCH AT B: $I_F$ = 7.5mA
$I_F$
R
A
B
$V_{FF}$
VCC
GND
1
2
3
4
5
6
7
8
+5V
.01μF BYPASS
350Ω
+
$V_O$
-
$V_{CM}$
+
–
HP 1900A PULSE GEN.
$Z_O$ = 50Ω

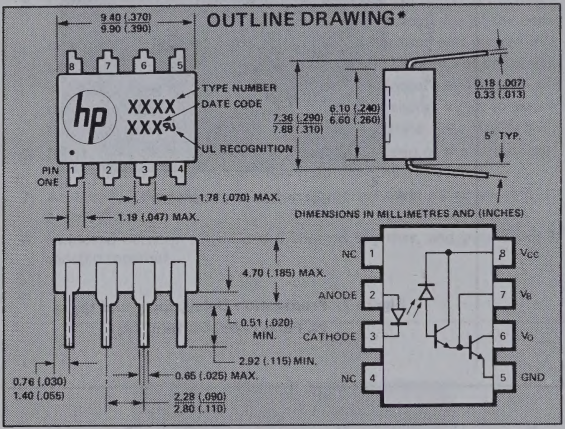
Figure 9. Test Circuit for Transient Immunity and Typical Waveforms.

**HEWLETT PACKARD**

# LOW INPUT CURRENT, HIGH GAIN OPTOCOUPLERS

**6N138**
**6N139**

TECHNICAL DATA FEBRUARY 1982



OUTLINE DRAWING*

9.40 (.370)
9.90 (.390)
8
7
6
5
hp
XXXX
XXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
PIN ONE
1
2
3
4
1.78 (.070) MAX.
1.19 (.047) MAX.
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
DIMENSIONS IN MILLIMETRES AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
NC
ANODE
CATHODE
NC
VCC
VB
VO
GND

## Features

- **HIGH CURRENT TRANSFER RATIO — 800% TYPICAL**
- **LOW INPUT CURRENT REQUIREMENT — 0.5mA**
- **TTL COMPATIBLE OUTPUT — 0.1V $V_{OL}$**
- **3000 Vdc WITHSTAND TEST VOLTAGE**
- **HIGH COMMON MODE REJECTION — 500V/μs**
- **PERFORMANCE GUARANTEED OVER TEMPERATURE 0°C to 70°C**
- **BASE ACCESS ALLOWS GAIN BANDWIDTH ADJUSTMENT**
- **HIGH OUTPUT CURRENT — 60mA**
- **DC TO 1M bit/s OPERATION**
- **RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)**

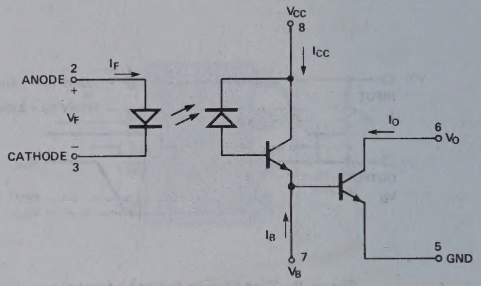
## Description

These high gain series couplers use a Light Emitting Diode and an integrated high gain photon detector to provide 3000V dc electrical insulation, 500V/μs common mode transient immunity and extremely high current transfer ratio between input and output. Separate pins for the photodiode and output stage result in TTL compatible saturation voltages and high speed operation. Where desired the $V_{CC}$ and $V_O$ terminals may be tied together to achieve conventional photodarlington operation. A base access terminal allows a gain bandwidth adjustment to be made.

The 6N139 is suitable for use in CMOS, LTTL or other low power applications. A 400% minimum current transfer ratio is guaranteed over a 0-70°C operating range for only 0.5mA of LED current.

The 6N138 is suitable for use mainly in TTL applications. Current Transfer Ratio is 300% minimum over 0-70°C for an LED current of 1.6mA [1 TTL unit load (U.L.)]. A 300% minimum CTR enables operation with 1 U.L. in, 1 U.L. out with a 2.2 kΩ pull-up resistor.

**SCHEMATIC**



$V_{CC}$
8
$I_{CC}$
ANODE
2
+
$I_F$
$V_F$
CATHODE
–
3
$I_O$
6
$V_O$
$I_B$
7
$V_B$
5
GND

## Applications

- Ground Isolate Most Logic Families – TTL/TTL, CMOS/TTL, CMOS/CMOS, LTTL/TTL, CMOS/LTTL
- Low Input Current Line Receiver – Long Line or Partyline
- EIA RS-232C Line Receiver
- Telephone Ring Detector
- 117 V ac Line Voltage Status Indicator – Low Input Power Dissipation
- Low Power Systems – Ground Isolation

## Absolute Maximum Ratings*

Storage Temperature . . . . . . . . . . . . –55°C to +125°C
Operating Temperature . . . . . . . . . . . . . . . 0°C to +70°C
Lead Solder Temperature . . . . . . . . . . . 260°C for 10s (1.6mm below seating plane)
Average Input Current – $I_F$ . . . . . . . . . . . . . . . 20mA [1]
Peak Input Current – $I_F$ . . . . . . . . . . . . . . . . . . . 40mA (50% duty cycle, 1 ms pulse width)
Peak Transient Input Current – $I_F$ . . . . . . . . . . . . . . 1.0A (≤ 1μs pulse width, 300 pps)
Reverse Input Voltage – $V_R$ . . . . . . . . . . . . . . . . . 5V
Input Power Dissipation . . . . . . . . . . . . . . . . 35mW [2]
Output Current – $I_O$ (Pin 6) . . . . . . . . . . . . . 60mA [3]
Emitter-Base Reverse Voltage (Pin 5-7) . . . . . . . . . . . 0.5V
Supply and Output Voltage – $V_{CC}$ (Pin 8-5), $V_O$ (Pin 6-5)
6N138 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .–0.5 to 7V
6N139 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .–0.5 to 18V
Output Power Dissipation . . . . . . . . . . . . . . . . 100mW [4]

See notes, following page.

*CAUTION: The small junction sizes inherent to the design of this bipolar component increases the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.*

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*JEDEC Registered Data.

# Electrical Specifications

## OVER RECOMMENDED TEMPERATURE ($T_A = 0°C$ to $70°C$), UNLESS OTHERWISE SPECIFIED

| Parameter | Sym. | Device | Min. | Typ.** | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR* | 6N139 | 400 | 800 | | % | $I_F = 0.5mA, V_O = 0.4V, V_{CC} = 4.5V$ | 3 | 5,6 |
| | | | 500 | 900 | | | $I_F = 1.6mA, V_O = 0.4V, V_{CC} = 4.5V$ | | |
| | | 6N138 | 300 | 600 | | % | $I_F = 1.6mA, V_O = 0.4V, V_{CC} = 4.5V$ | | |
| Logic Low Output Voltage | $V_{OL}$ | 6N139 | | 0.1 | 0.4 | V | $I_F = 1.6mA, I_O = 6.4mA, V_{CC} = 4.5V$ | 1,2 | 6 |
| | | | | 0.1 | 0.4 | | $I_F = 5mA, I_O = 15mA, V_{CC} = 4.5V$ | | |
| | | | | 0.2 | 0.4 | | $I_F = 12mA, I_O = 24mA, V_{CC} = 4.5V$ | | |
| | | 6N138 | | 0.1 | 0.4 | V | $I_F = 1.6mA, I_O = 4.8mA, V_{CC} = 4.5V$ | | |
| Logic High Output Current | $I_{OH}$* | 6N139 | | 0.05 | 100 | µA | $I_F = 0mA, V_O = V_{CC} = 18V$ | | 6 |
| | | 6N138 | | 0.1 | 250 | µA | $I_F = 0mA, V_O = V_{CC} = 7V$ | | |
| Logic Low Supply Current | $I_{CCL}$ | | | 0.2 | | mA | $I_F = 1.6mA, V_O = \text{Open}, V_{CC} = 5V$ | | 6 |
| Logic High Supply Current | $I_{CCH}$ | | | 10 | | nA | $I_F = 0mA, V_O = \text{Open}, V_{CC} = 5V$ | | 6 |
| Input Forward Voltage | $V_F$* | | | 1.4 | 1.7 | V | $I_F = 1.6mA, T_A = 25°C$ | 4 | |
| Input Reverse Breakdown Voltage | $BV_R$* | | 5 | | V | | $I_R = 10\mu A, T_A = 25°C$ | | |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | | | −1.8 | | mV/°C | $I_F = 1.6mA$ | | |
| Input Capacitance | $C_{IN}$ | | | 60 | | pF | $f = 1MHz, V_F = 0$ | | |
| Input - Output Insulation Leakage Current | $I_{I-O}$* | | | | 1.0 | µA | 45% Relative Humidity, $T_A = 25°C$<br>$t = 5\ s, V_{I-O} = 3000Vdc$ | | 7 |
| Resistance (Input-Output) | $R_{I-O}$ | | | $10^{12}$ | | Ω | $V_{I-O} = 500Vdc$ | | 7 |
| Capacitance (Input-Output) | $C_{I-O}$ | | | 0.6 | | pF | $f = 1MHz$ | | 7 |

**All typicals at $T_A = 25°C$ and $V_{CC} = 5V$, unless otherwise noted.

# Switching Specifications

## AT $T_A = 25°C$

| Parameter | Sym. | Device | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time To Logic Low at Output | $t_{PHL}$* | 6N139 | | 5 | 25 | µs | $I_F = 0.5mA, R_L = 4.7k\Omega$ | 9 | 6,8 |
| | | | | 0.2 | 1 | | $I_F = 12mA, R_L = 270\Omega$ | | |
| | | 6N138 | | 1 | 10 | µs | $I_F = 1.6mA, R_L = 2.2k\Omega$ | | |
| Propagation Delay Time To Logic High at Output | $t_{PLH}$* | 6N139 | | 5 | 60 | µs | $I_F = 0.5mA, R_L = 4.7k\Omega$ | 9 | 6,8 |
| | | | | 1 | 7 | | $I_F = 12mA, R_L = 270\Omega$ | | |
| | | 6N138 | | 4 | 35 | µs | $I_F = 1.6mA, R_L = 2.2k\Omega$ | | |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ | | | 500 | | V/µs | $I_F = 0mA, R_L = 2.2k\Omega, R_{CC} = 0$<br>$\lvert V_{cm}\rvert = 10V_{p\text{-}p}$ | 10 | 9,10 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ | | | −500 | | V/µs | $I_F = 1.6mA, R_L = 2.2k\Omega, R_{CC} = 0$<br>$\lvert V_{cm}\rvert = 10V_{p\text{-}p}$ | 10 | 9,10 |

**NOTES:**

1. Derate linearly above 50°C free-air temperature at a rate of 0.4mA/°C.
2. Derate linearly above 50°C free-air temperature at a rate of 0.7mW/°C.
3. Derate linearly above 25°C free-air temperature at a rate of 0.7mA/°C.
4. Derate linearly above 25°C free-air temperature at a rate of 2.0mW/°C.
5. DC CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
6. Pin 7 Open.
7. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
8. Use of a resistor between pin 5 and 7 will decrease gain and delay time. See Application Note 951-1 for more details.
9. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{cm}/dt$ on the leading edge of the common mode pulse, $V_{cm}$, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{cm}/dt$ on the trailing edge of the common mode pulse signal, $V_{cm}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$).
10. In applications where dV/dt may exceed 50,000V/µs (such as static discharge) a series resistor, $R_{CC}$, should be included to protect the detector IC from destructively high surge currents. The recommended value is $R_{CC} \approx \frac{1V}{0.15\ I_F\ (mA)}\ k\Omega$.

*JEDEC Registered Data.

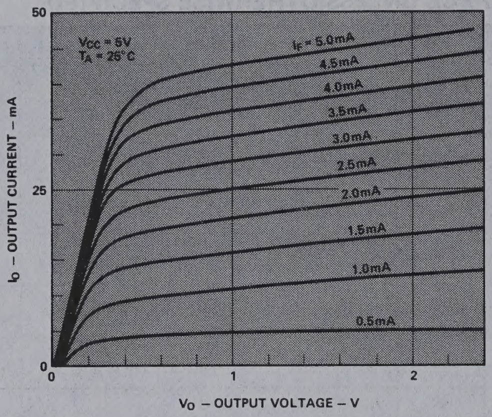


Figure 1. 6N139 DC Transfer Characteristics.

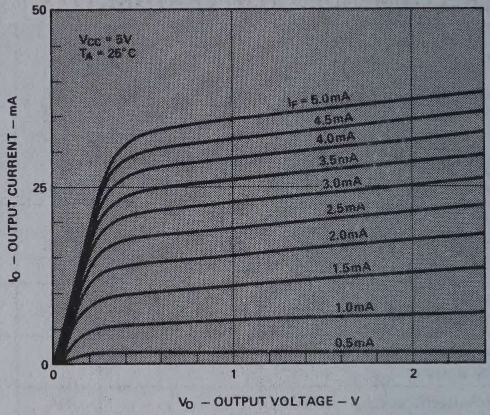


Figure 2. 6N138 DC Transfer Characteristics.

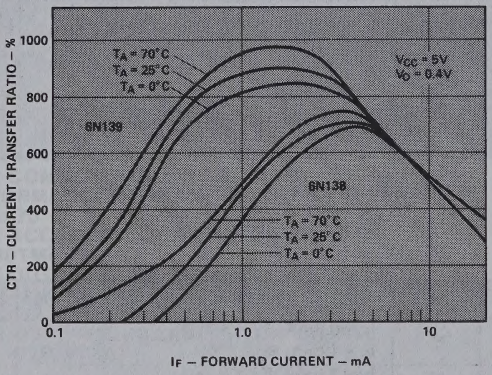


Figure 3. Current Transfer Ratio vs. Forward Current.

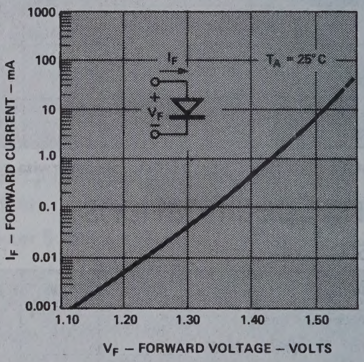


Figure 4. Input Diode Forward Current vs. Forward Voltage.

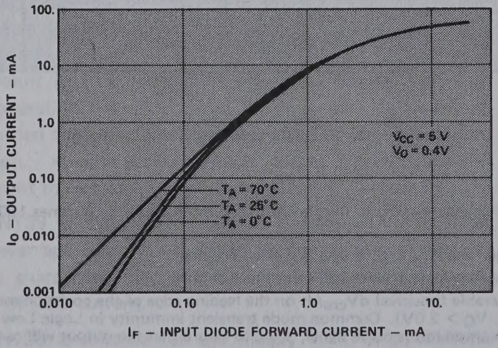


Figure 5. 6N139 Output Current vs. Input Diode Forward Current.

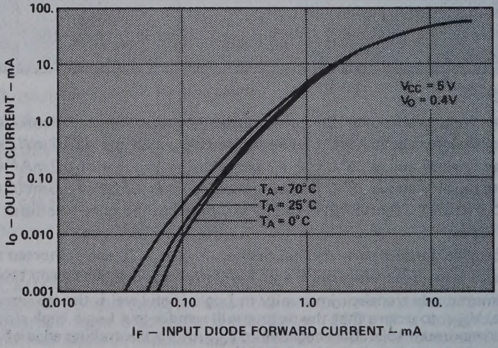


Figure 6. 6N138 Output Current vs. Input Diode Forward Current.

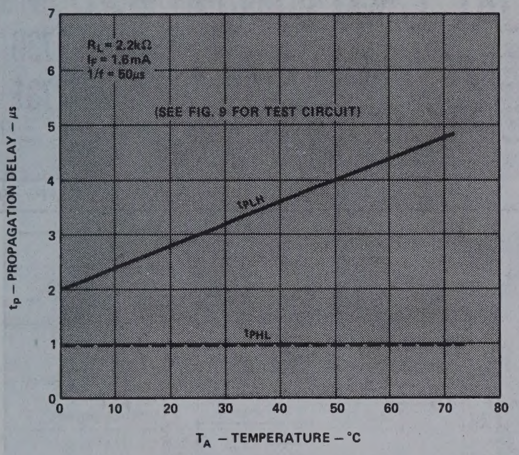


**Figure 7. Propagation Delay vs. Temperature.**

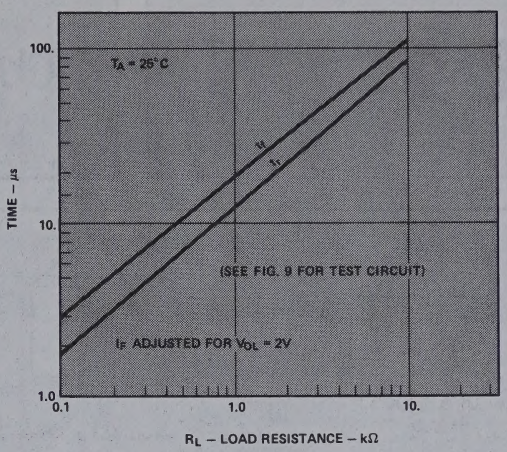
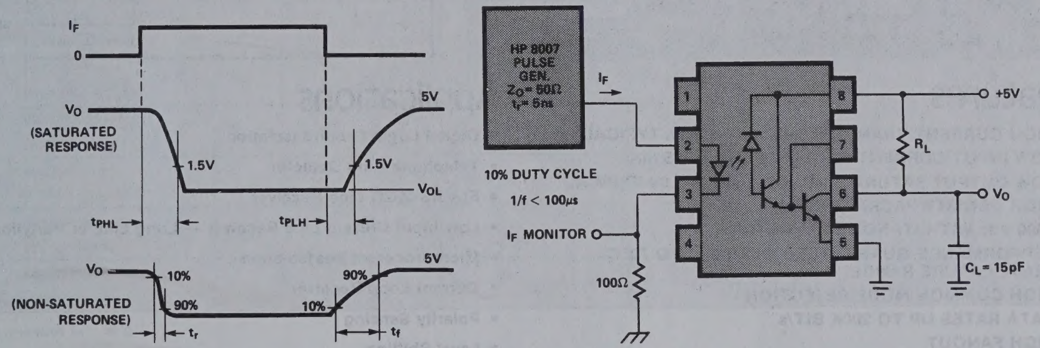
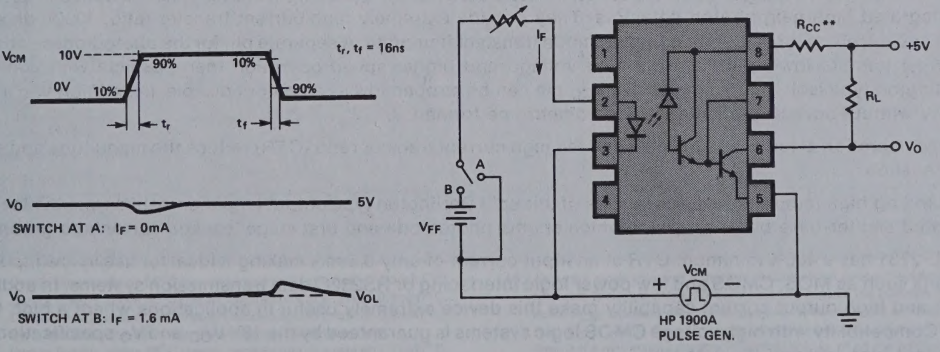


**Figure 8. Non Saturated Rise and Fall Times vs. Load Resistance.**



I<sub>F</sub>
0
V<sub>O</sub>
(SATURATED RESPONSE)
5V
1.5V
1.5V
V<sub>OL</sub>
t<sub>PHL</sub>
t<sub>PLH</sub>
V<sub>O</sub>
(NON-SATURATED RESPONSE)
10%
90%
90%
10%
5V
t<sub>r</sub>
t<sub>f</sub>
HP 8007 PULSE GEN. Z<sub>O</sub> = 50Ω t<sub>r</sub> = 5ns
I<sub>F</sub>
10% DUTY CYCLE
1/f < 100μs
I<sub>F</sub> MONITOR
100Ω
1
2
3
4
8
7
6
5
+5V
R<sub>L</sub>
V<sub>O</sub>
C<sub>L</sub> = 15pF

**Figure 9. Switching Test Circuit.***



V<sub>CM</sub>
10V
0V
90%
10%
10%
90%
t<sub>r</sub>, t<sub>f</sub> = 16ns
t<sub>r</sub>
t<sub>f</sub>
V<sub>O</sub>
5V
SWITCH AT A: I<sub>F</sub> = 0mA
V<sub>O</sub>
V<sub>OL</sub>
SWITCH AT B: I<sub>F</sub> = 1.6 mA
I<sub>F</sub>
A
B
V<sub>FF</sub>
R<sub>CC</sub>**
+5V
R<sub>L</sub>
V<sub>O</sub>
1
2
3
4
8
7
6
5
V<sub>CM</sub>
+
–
HP 1900A PULSE GEN.

**Figure 10. Test Circuit for Transient Immunity and Typical Waveforms.**

*JEDEC Registered Data.

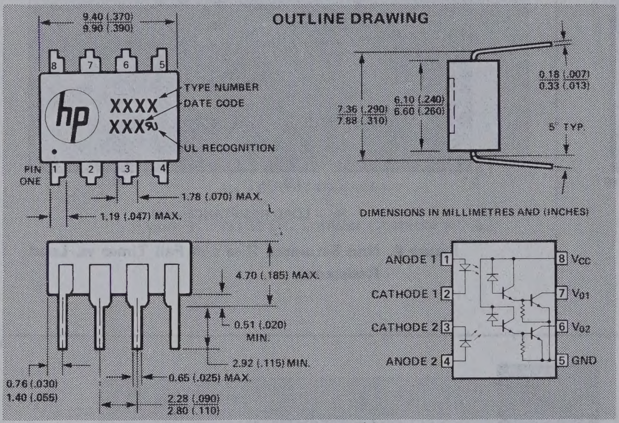
**See Note 10

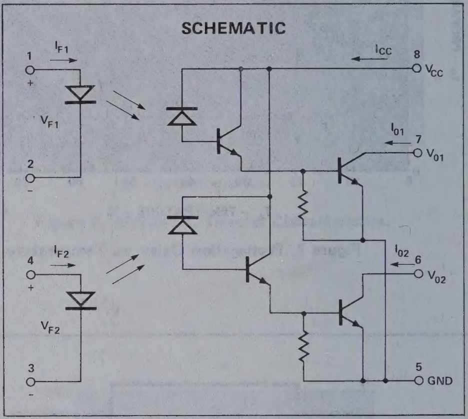
HEWLETT PACKARD

# DUAL LOW INPUT CURRENT, HIGH GAIN OPTOCOUPLERS

## HCPL-2730
## HCPL-2731

TECHNICAL DATA FEBRUARY 1982


OUTLINE DRAWING
9.40 (.370)
9.90 (.390)
8 7 6 5
XXXX
XXX
TYPE NUMBER
DATE CODE
UL RECOGNITION
PIN ONE
1 2 3 4
1.78 (.070) MAX.
1.19 (.047) MAX.
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP.
DIMENSIONS IN MILLIMETRES AND (INCHES)
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
0.76 (.030)
1.40 (.055)
2.28 (.090)
2.80 (.110)
ANODE 1 1
CATHODE 1 2
CATHODE 2 3
ANODE 2 4
8 VCC
7 VO1
6 VO2
5 GND


SCHEMATIC
IF1
1
+
VF1
2
-
ICC
8
VCC
IO1
7
VO1
IF2
4
+
VF2
3
-
IO2
6
VO2
5
GND

## Features

- HIGH CURRENT TRANSFER RATIO — 1000% TYPICAL
- LOW INPUT CURRENT REQUIREMENT — 0.5 mA
- LOW OUTPUT SATURATION VOLTAGE — 1.0V TYPICAL
- HIGH DENSITY PACKAGING
- 3000 Vdc WITHSTAND TEST VOLTAGE
- PERFORMANCE GUARANTEED OVER 0°C TO 70°C TEMPERATURE RANGE
- HIGH COMMON MODE REJECTION
- DATA RATES UP TO 200K BIT/s
- HIGH FANOUT
- RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361).

## Applications

- Digital Logic Ground Isolation
- Telephone Ring Detector
- EIA RS-232C Line Receiver
- Low Input Current Line Receiver — Long Line or Partyline
- Microprocessor Bus Isolation
- Current Loop Receiver
- Polarity Sensing
- Level Shifting
- Line Voltage Status Indicator — Low input Power Dissipation

## Description

The HCPL-2730/31 dual channel couplers contain a separated pair of GaAsP light emitting diodes optically coupled to a pair of integrated high gain photon detectors. They provide extremely high current transfer ratio, 3000V dc electrical insulation and excellent input-output common mode transient immunity. A separate pin for the photodiodes and first gain stages ($V_{CC}$) permits lower output saturation voltage and higher speed operation than possible with conventional photodarlington type isolators. The separate $V_{CC}$ pin can be strobed low as an output disable. In addition $V_{CC}$ may be as low as 1.6V without adversely affecting the parametric performance.

Guaranteed operation at low input currents and the high current transfer ratio (CTR) reduce the magnitude and effects of CTR degradation.

The outstanding high temperature performance of this split Darlington type output amplifier results from the inclusion of an integrated emitter-base bypass resistor which shunts photodiode and first stage leakage currents to ground.

The HCPL-2731 has a 400% minimum CTR at an input current of only 0.5 mA making it ideal for use in low input current applications such as MOS, CMOS and low power logic interfacing or RS232C data transmission systems. In addition, the high CTR and high output current capability make this device extremely useful in applications where a high fanout is required. Compatibility with high voltage CMOS logic systems is guaranteed by the 18V $V_{CC}$ and $V_O$ specifications and by testing output high leakage ($I_{OH}$) at 18V.

The HCPL-2730 is specified at an input current of 1.6 mA and has a 7V $V_{CC}$ and $V_O$ rating. The 300% minimum CTR allows TTL to TTL interfacing with an input current of only 1.6 mA.

Important specifications such as CTR, leakage current and output saturation voltage are guaranteed over the 0°C to 70°C temperature range to allow trouble-free system operation.

# Electrical Specifications

(Over Recommended Temperature $T_A = 0°C$ to $70°C$, Unless Otherwise Specified)

| Parameter | Sym. | Device HCPL- | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR | 2731 | 400 | 1000 | | % | $I_F = 0.5mA$, $V_O = 0.4V$, $V_{CC} = 4.5V$ | 2 | 6,7 |
| | | | 500 | 1100 | | | $I_F = 1.6mA$, $V_O = 0.4V$, $V_{CC} = 4.5V$ | | |
| | | 2730 | 300 | 1000 | | % | $I_F = 1.6mA$, $V_O = 0.4V$, $V_{CC} = 4.5V$ | 2 | |
| Logic Low Output Voltage | $V_{OL}$ | 2731 | | 0.1 | 0.4 | V | $I_F = 1.6mA$, $I_O = 8mA$, $V_{CC} = 4.5V$ | 1 | 6 |
| | | | | 0.1 | 0.4 | | $I_F = 5mA$, $I_O = 15mA$, $V_{CC} = 4.5V$ | | |
| | | | | 0.2 | 0.4 | | $I_F = 12mA$, $I_O = 24mA$, $V_{CC} = 4.5V$ | | |
| | | 2730 | | 0.1 | 0.4 | V | $I_F = 1.6mA$, $I_O = 4.8mA$, $V_{CC} = 4.5V$ | | |
| Logic High Output Current | $I_{OH}$ | 2731 | | 0.005 | 100 | µA | $I_F = 0 mA$, $V_O = V_{CC} = 18V$ | | 6 |
| | | 2730 | | 0.01 | 250 | µA | $I_F = 0mA$, $V_O = V_{CC} = 7V$ | | |
| Logic Low Supply Current | $I_{CCL}$ | 2731 | | 1.2 | | mA | $I_{F1} = I_{F2} = 1.6mA$<br>$V_{01} = V_{02} =$ Open; $V_{CC} = 18V$ | | |
| | | 2730 | | 0.9 | | | $V_{CC} = 7V$ | | |
| Logic High Supply Current | $I_{CCH}$ | 2731 | | 5 | | nA | $I_{F1} = I_{F2} = 0mA$<br>$V_{01} = V_{02} =$ Open; $V_{CC} = 18V$ | | |
| | | 2730 | | 4 | | | $V_{CC} = 7V$ | | |
| Input Forward Voltage | $V_F$ | | | 1.4 | 1.7 | V | $I_F = 1.6mA$, $T_A = 25°C$ | 4 | 6 |
| Input Reverse Breakdown Voltage | $BV_R$ | | 5 | | | V | $I_R = 10$ µA, $T_A = 25°C$ | | |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | | | -1.8 | | mV/°C | $I_F = 1.6mA$ | | 6 |
| Input Capacitance | $C_{IN}$ | | | 60 | | pF | f = 1 MHz, $V_F = 0$ | | 6 |
| Input-Output Insulation Leakage Current | $I_{I\text{-}O}$ | | | | 1.0 | µA | 45% Relative Humidity, $T_A = 25°C$<br>t = 5s, $V_{I\text{-}O} = 3000 Vdc$ | | 8 |
| Resistance (Input-Output) | $R_{I\text{-}O}$ | | | $10^{12}$ | | Ω | $V_{I\text{-}O} = 500Vdc$ | | 8 |
| Capacitance (Input-Output) | $C_{I\text{-}O}$ | | | 0.6 | | pF | f = 1 MHz | | 8 |
| Input-Input Insulation Leakage Current | $I_{I\text{-}I}$ | | | 0.005 | | µA | 45% Relative Humidity, t=5s,<br>$V_{I\text{-}I} = 500Vdc$ | | 9 |
| Resistance (Input-Input) | $R_{I\text{-}I}$ | | | $10^{11}$ | | Ω | $V_{I\text{-}I} = 500Vdc$ | | 9 |
| Capacitance (Input-Input) | $C_{I\text{-}I}$ | | | 0.25 | | pF | f = 1 MHz | | 9 |

*All typicals at $T_A = 25°C$

# Switching Specifications at $T_A$=25°C

| Parameter | Sym. | Device HCPL- | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time To Logic Low at Output | $t_{PHL}$ | 2731 | | 25 | 100 | µs | $I_F = 0.5mA$, $R_L = 4.7kΩ$ | 9 | |
| | | 2730/1 | | 5 | 20 | µs | $I_F = 1.6mA$, $R_L = 2.2kΩ$ | | |
| | | | | 0.5 | 2 | | $I_F = 12mA$, $R_L = 270Ω$ | | |
| Propagation Delay Time To Logic High at Output | $t_{PLH}$ | 2731 | | 20 | 60 | µs | $I_F = 0.5mA$, $R_L = 4.7kΩ$ | 9 | |
| | | 2730/1 | | 10 | 35 | µs | $I_F = 1.6mA$, $R_L = 2.2kΩ$ | | |
| | | | | 1 | 10 | | $I_F = 12mA$, $R_L = 270Ω$ | | |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ | | | 500 | | V/µs | $I_F = 0mA$, $R_L = 2.2kΩ$<br>$\lvert V_{CM} \rvert = 10V_{p\text{-}p}$ | 10 | 10,11 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ | | | -500 | | V/µs | $I_F = 1.6mA$, $R_L = 2.2kΩ$<br>$\lvert V_{CM} \rvert = 10V_{p\text{-}p}$ | 10 | 10,11 |

NOTES:
1. Derate linearly above 50°C free-air temperature at a rate of 0.5mA/°C.
2. Derate linearly above 50°C free-air temperature at a rate of 0.9mW/°C.
3. Derate linearly above 35°C free-air temperature at a rate of 0.6mA/°C.
4. Pin 5 should be the most negative voltage at the detector side.
5. Derate linearly above 35°C free-air temperature at a rate of 1.7mW/°C. Output power is collector output power plus supply power.
6. Each channel.
7. CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
8. Device considered a two-terminal device: Pins 1, 2, 3, and 4 shorted together and Pins 5, 6, 7, and 8 shorted together.
9. Measured between pins 1 and 2 shorted together, and pins 3 and 4 shorted together.
10. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the leading edge of the common mode pulse $V_{CM}$, to assure that the output will remain in Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM}$ dt on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$).
11. In applications where dV/dt may exceed 50,000 V/µs (such as a static discharge) a series resistor, $R_{CC}$, should be included to protect the detector IC from destructively high surge currents. The recommended value is $R_{CC} \approx \frac{1V}{0.3\ I_F\ (mA)}$ kΩ.

# Absolute Maximum Ratings

Storage Temperature .......... -55°C to +125°C
Operating Temperature ......... -40°C to +85°C
Lead Solder Temperature ....... 260°C for 10 sec
(1.6mm below seating plane)
Average Input Current — $I_F$
(each channel) ..................... 20 mA[1]
Peak Input Current — $I_F$
(each channel) ...................... 40 mA
(50% duty cycle, 1 ms pulse width)
Reverse Input Voltage — $V_R$
(each channel) ......................... 5V

Input Power Dissipation
(each channel) .................. 35 mW[2]
Output Current — $I_O$
(each channel) .................. 60 mA[3]
Supply and Output Voltage — $V_{CC}$ (Pin 8-5), $V_O$ (Pin 7,6-5)[4]
HCPL-2730 ...................... -0.5 to 7V
HCPL-2731 ...................... -0.5 to 18V
Output Power Dissipation
(each channel) .................. 100 mW[5]

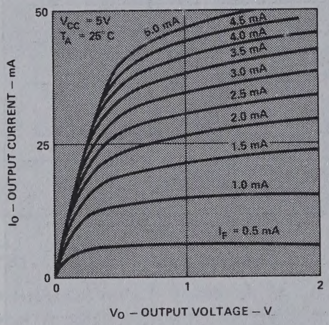


**Figure 1. DC Transfer Characteristics.**

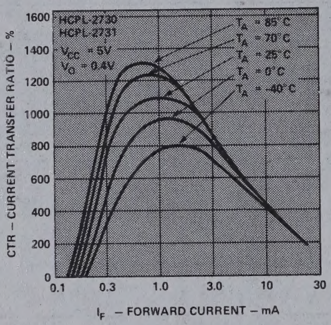


**Figure 2. Current Transfer Ratio vs. Forward Current.**

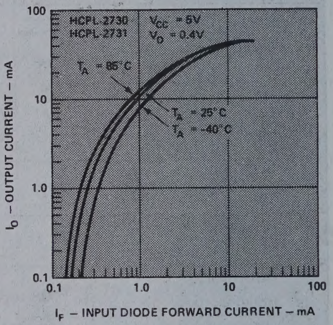


**Figure 3. Output Current vs. Input Diode Forward Current.**

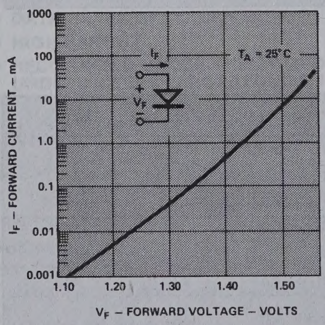


**Figure 4. Input Diode Forward Current vs. Forward Voltage.**

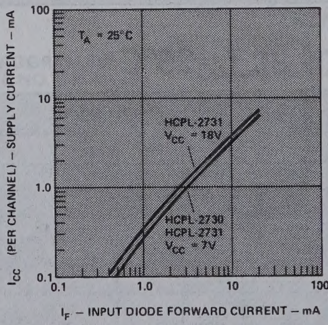


**Figure 5. Supply Current Per Channel vs. Input Diode Forward Current.**

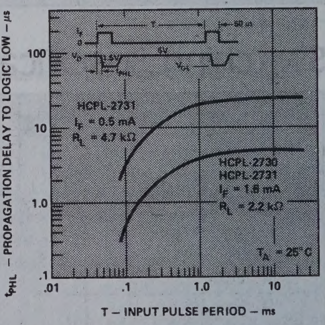


**Figure 6. Propagation Delay To Logic Low vs. Pulse Period.**

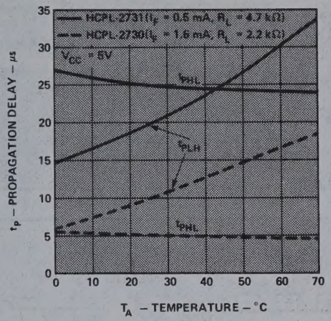


**Figure 7. Propagation Delay vs. Temperature.**

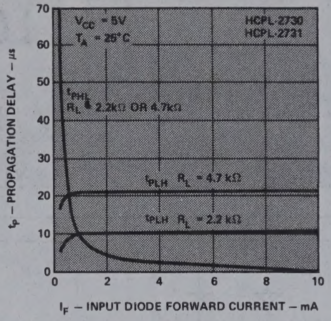


**Figure 8. Propagation Delay vs. Input Diode Forward Current.**

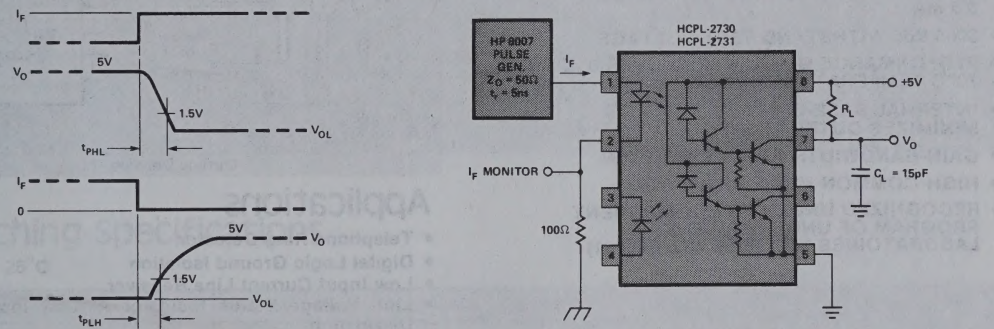
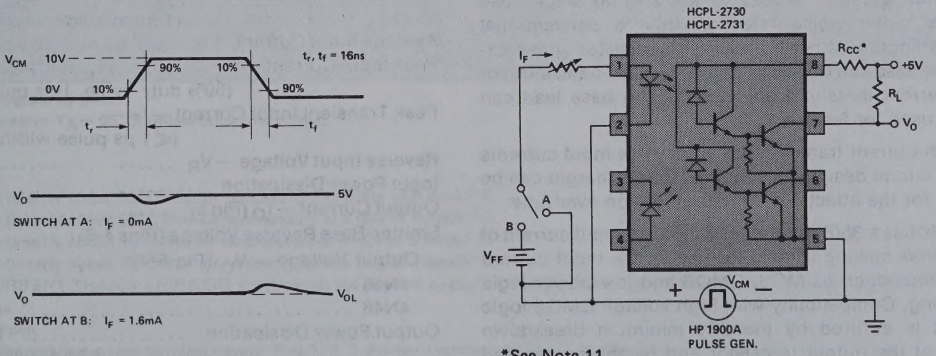

I_F
V_O
5V
1.5V
V_OL
t_PHL
I_F
0
5V
V_O
1.5V
V_OL
t_PLH
HP 8007 PULSE GEN. Z_O = 50Ω t_r = 5ns
I_F
HCPL-2730
HCPL-2731
+5V
R_L
V_O
I_F MONITOR
C_L = 15pF
100Ω
1
2
3
4
5
6
7
8

**Figure 9. Switching Test Circuit.**


V_CM
10V
0V
90%
10%
10%
90%
t_r, t_f = 16ns
t_r
t_f
V_O
5V
SWITCH AT A: I_F = 0mA
V_O
V_OL
SWITCH AT B: I_F = 1.6mA
HCPL-2730
HCPL-2731
I_F
R_CC*
+5V
R_L
V_O
A
B
V_FF
V_CM
+
–
HP 1900A PULSE GEN.
1
2
3
4
5
6
7
8

*See Note 11.

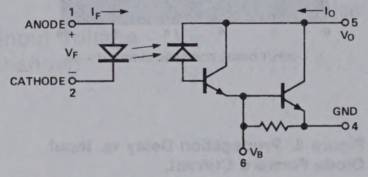
**Figure 10. Test Circuit for Transient Immunity and Typical Waveforms.**

**HEWLETT PACKARD**

# LOW INPUT CURRENT, HIGH GAIN OPTOCOUPLER

## 4N45
## 4N46

TECHNICAL DATA FEBRUARY 1982



Schematic

## Features

- **HIGH CURRENT TRANSFER RATIO — 1000% TYPICAL**
- **LOW INPUT CURRENT REQUIREMENT — 0.5 mA**
- **3000 Vdc WITHSTAND TEST VOLTAGE**
- **PERFORMANCE GUARANTEED OVER 0° C TO 70° C TEMPERATURE RANGE**
- **INTERNAL BASE-EMITTER RESISTOR MINIMIZES OUTPUT LEAKAGE**
- **GAIN-BANDWIDTH ADJUSTMENT PIN**
- **HIGH COMMON MODE REJECTION**
- **RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES INC. (FILE NO. E55361)**

## Description

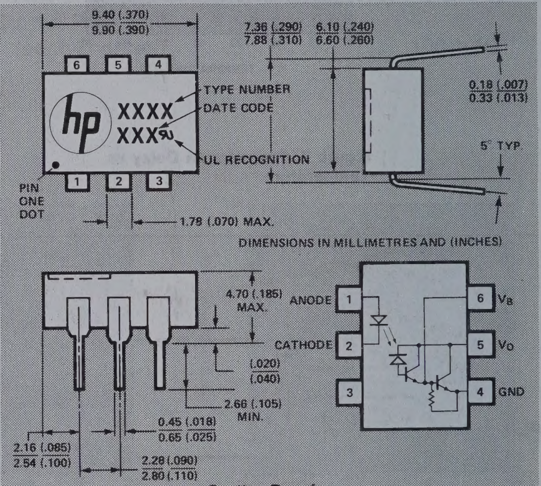
The 4N45/46 optocouplers contain a GaAsP light emitting diode optically coupled to a high gain photodetector IC.

The excellent performance over temperature results from the inclusion of an integrated emitter-base bypass resistor which shunts photodiode and first stage leakage currents to ground. External access to the second stage base provides better noise rejection than a conventional photodarlington detector. An external resistor or capacitor at the base can be added to make a gain-bandwidth or input current threshold adjustment. The base lead can also be used for feedback.

The high current transfer ratio at very low input currents permits circuit designs in which adequate margin can be allowed for the effects of CTR degradation over time.

The 4N46 has a 350% minimum CTR at an input current of only 0.5mA making it ideal for use in low input current applications such as MOS, CMOS and low power logic interfacing. Compatibility with high voltage CMOS logic systems is assured by the 20V minimum breakdown voltage of the output transistor and by the guaranteed maximum output leakage ($I_{OH}$) at 18V.

The 4N45 has a 250% minimum CTR at 1.0mA input current and a 7V minimum breakdown voltage rating.



Outline Drawing

## Applications

- **Telephone Ring Detector**
- **Digital Logic Ground Isolation**
- **Low Input Current Line Receiver**
- **Line Voltage Status Indicator — Low Input Power Dissipation**
- **Logic to Reed Relay Interface**
- **Level Shifting**
- **Interface Between Logic Families**

## Absolute Maximum Ratings*

| | |
|---|---|
| Storage Temperature | -55° C to +125° C |
| Operating Temperature | -40° C to +70° C |
| Lead Solder Temperature | 260° C for 10 s.<br>(1.6mm below seating plane) |
| Average Input Current — $I_F$ | 20 mA[1] |
| Peak Input Current — $I_F$ | 40 mA<br>(50% duty cycle, 1ms pulse width) |
| Peak Transient Input Current — $I_F$ | 1.0A<br>(≤1 μs pulse width, 300pps) |
| Reverse Input Voltage — $V_R$ | 5V |
| Input Power Dissipation | 35mW[2] |
| Output Current — $I_O$ (Pin 5) | 60 mA[3] |
| Emitter-Base Reverse Voltage (Pins 4-6) | 0.5V |
| Output Voltage — $V_O$ (Pin 5-4) | |
| 4N45 | -0.5 to 7V |
| 4N46 | -0.5 to 20V |
| Output Power Dissipation | 100mW[4] |

See notes, following page

*CAUTION: The small junction sizes inherent to the design of this bipolar component increases the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.*

*JEDEC Registered Data.

# Electrical Specifications

OVER RECOMMENDED TEMPERATURE ($T_A$ = 0°C TO 70°C), UNLESS OTHERWISE SPECIFIED

| Parameter | Sym. | Device | Min. | Typ.** | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR* | 4N46 | 350 | 1500 |  | % | $I_F$ = 0.5mA, $V_O$ = 1.0V | 4 | 5,6 |
|  |  |  | 500 | 1500 |  |  | $I_F$ = 1.0mA, $V_O$ = 1.0V |  |  |
|  |  |  | 200 | 600 |  |  | $I_F$ = 10mA, $V_O$ = 1.2V |  |  |
|  |  | 4N45 | 250 | 1200 |  | % | $I_F$ = 1.0mA, $V_O$ = 1.0V |  |  |
|  |  |  | 200 | 500 |  |  | $I_F$ = 10mA, $V_O$ = 1.2V |  |  |
| Logic Low Output Voltage | $V_{OL}$ | 4N46 |  | .90 | 1.0 | V | $I_F$ = 0.5mA, $I_{OL}$ = 1.75mA | 2 | 6 |
|  |  |  |  | .92 | 1.0 |  | $I_F$ = 1.0mA, $I_{OL}$ = 5.0mA |  |  |
|  |  |  |  | .95 | 1.2 |  | $I_F$ = 10mA, $I_{OL}$ = 20mA |  |  |
|  |  | 4N45 |  | .90 | 1.0 | V | $I_F$ = 1.0mA, $I_{OL}$ = 2.5mA |  |  |
|  |  |  |  | .95 | 1.2 |  | $I_F$ = 10mA, $I_{OL}$ = 20mA |  |  |
| Logic High Output Current | $I_{OH}$* | 4N46 |  | .001 | 100 | μA | $I_F$ = 0mA, $V_O$ = 18V |  | 6 |
|  |  | 4N45 |  | .001 | 250 | μA | $I_F$ = 0mA, $V_O$ = 5V |  |  |
| Input Forward Voltage | $V_F$* |  |  | 1.4 | 1.7 | V | $I_F$ = 1.0mA, $T_A$ = 25°C | 1 |  |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ |  |  | -1.8 |  | mV/°C | $I_F$ = 1.0mA |  |  |
| Input Reverse Breakdown Voltage | $BV_R$* |  | 5 |  |  | V | $I_R$ = 10μA, $T_A$ = 25°C |  |  |
| Input Capacitance | $C_{IN}$ |  |  | 60 |  | pF | f = 1MHz, $V_F$ = 0 |  |  |
| Input-Output Insulation Leakage Current | $I_{I-O}$* |  |  |  | 1.0 | μA | 45% Relative Humidity, $T_A$=25°C<br>t = 5 s, $V_{I-O}$ = 3000VDC |  | 7 |
| Resistance (Input-Output) | $R_{I-O}$ |  |  | $10^{12}$ |  | Ω | $V_{I-O}$ = 500VDC |  | 7 |
| Capacitance (Input-Output) | $C_{I-O}$ |  |  | 0.6 |  | pF | f = 1MHz |  | 7 |

# Switching Specifications

AT $T_A$ = 25°C

| Parameter | Symbol | Min. | Typ.** | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time To Logic Low at Output | $t_{PHL}$ |  | 80 |  | μs | $I_F$ = 1.0mA, $R_L$ = 10kΩ | 8 | 6,8 |
|  | $t_{PHL}$* |  | 5 | 50 | μs | $I_F$ = 10mA, $R_L$ = 220Ω |  |  |
| Propagation Delay Time To Logic High at Output | $t_{PLH}$ |  | 1500 |  | μs | $I_F$ = 1.0mA, $R_L$ = 10kΩ | 8 | 6,8 |
|  | $t_{PLH}$* |  | 150 | 500 | μs | $I_F$ = 10mA, $R_L$ = 220Ω |  |  |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ |  | 500 |  | V/μs | $I_F$ = 0mA, $R_L$ = 10kΩ<br>$\lvert V_{cm} \rvert$ = 10$V_{p-p}$ | 9 | 9 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ |  | -500 |  | V/μs | $I_F$ = 1.0mA, $R_L$ = 10kΩ<br>$\lvert V_{cm} \rvert$ = 10$V_{p-p}$ | 9 | 9 |

*JEDEC Registered Data.

**All typicals at $T_A$ = 25°C, unless otherwise noted.

NOTES:

1. Derate linearly above 50°C free-air temperature at a rate of 0.4mA/°C.
2. Derate linearly above 50°C free-air temperature at a rate of 0.7mW/°C.
3. Derate linearly above 25°C free-air temperature at a rate of 0.8mA/°C.
4. Derate linearly above 25°C free-air temperature at a rate of 1.5mW/°C.
5. DC CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
6. Pin 6 Open.
7. Device considered a two-terminal device: Pins 1, 2, 3 shorted together and Pins 4, 5, and 6 shorted together.
8. Use of a resistor between pin 4 and 6 will decrease gain and delay time. (See Figures 10 and 12).
9. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{cm}/dt$ on the leading edge of the common mode pulse, $V_{cm}$, to assure that the output will remain in a Logic High state (i.e., $V_O > 2.5V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{cm}/dt$ on the trailing edge of the common mode pulse signal, $V_{cm}$, to assure that the output will remain in a Logic Low state (i.e., $V_O < 2.5V$).

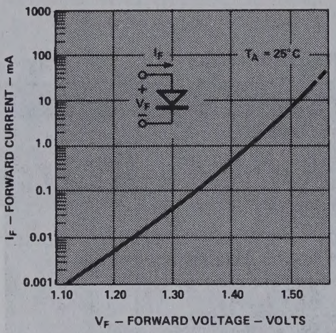


**Figure 1. Input Diode Forward Current vs. Forward Voltage.**

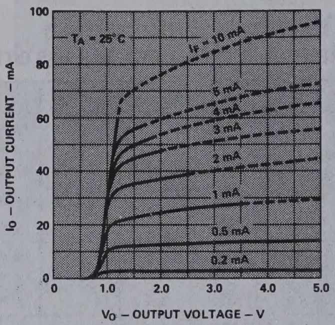


**Figure 2. Typical DC Transfer Characteristics.**

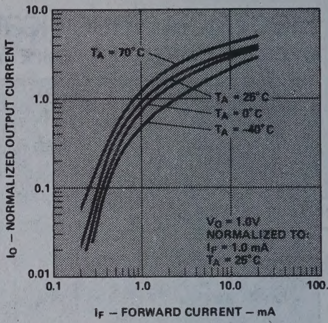


**Figure 3. Output Current vs. Input Current.**

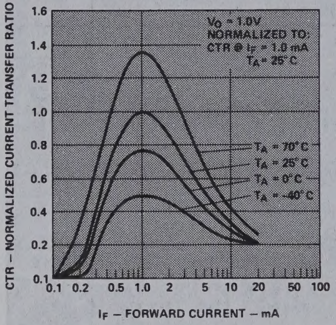


**Figure 4. Current Transfer Ratio vs. Input Current.**

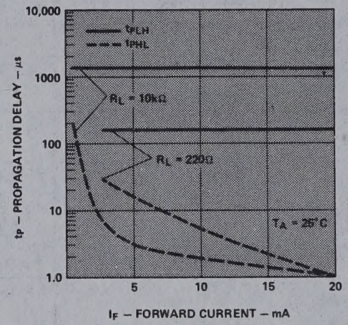


**Figure 5. Propagation Delay vs. Forward Current.**

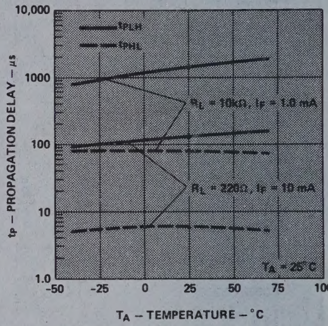


**Figure 6. Propagation Delay vs. Temperature.**

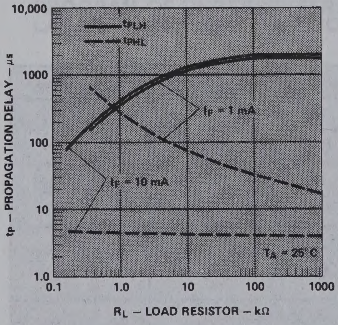


**Figure 7. Propagation Delay vs Load Resistor.**

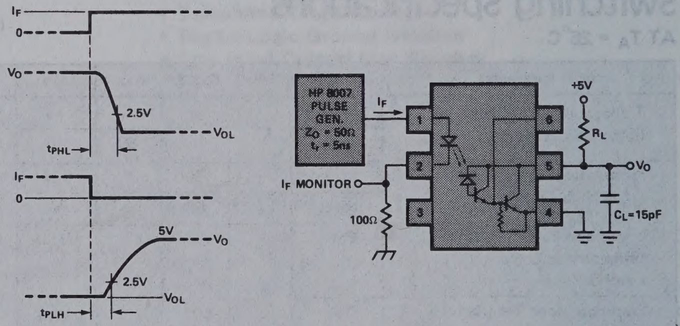

IF
0
VO
2.5V
VOL
tPHL
IF
0
5V
VO
2.5V
VOL
tPLH
HP 8007
PULSE
GEN.
ZO = 50Ω
tr = 5ns
IF
IF MONITOR
100Ω
1
2
3
4
5
6
+5V
RL
VO
CL=15pF

**Figure 8. Switching Test Circuit**

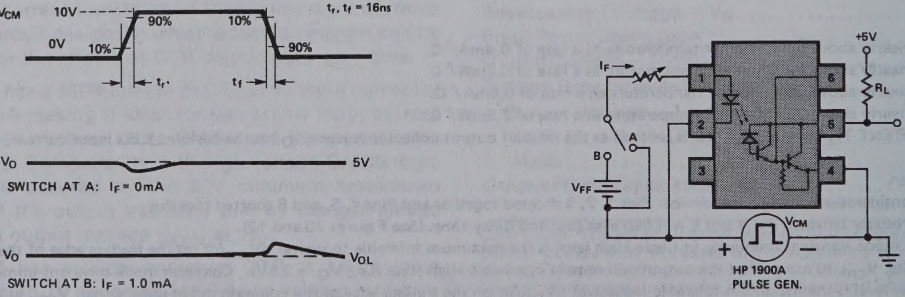
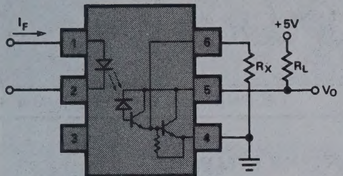

VCM
10V
0V
90%
10%
10%
90%
tr
tf
tr, tf = 16ns
VO
5V
SWITCH AT A: IF = 0mA
VO
VOL
SWITCH AT B: IF = 1.0 mA
IF
RL
+5V
1
2
3
4
5
6
VO
A
B
VFF
VCM
+
−
HP 1900A
PULSE GEN.

**Figure 9. Test Circuit for Transient Immunity and Typical Waveforms.**



I_F
1
2
3
6
5
4
+5V
R_X
R_L
V_O

**Figure 10. External Base Resistor, $R_X$**

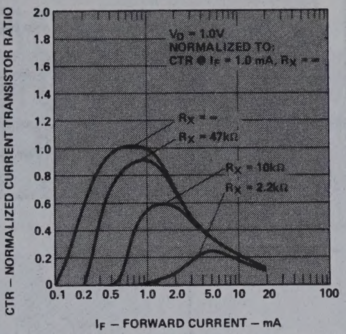


**Figure 11. Effect of $R_X$ On Current Transfer Ratio**

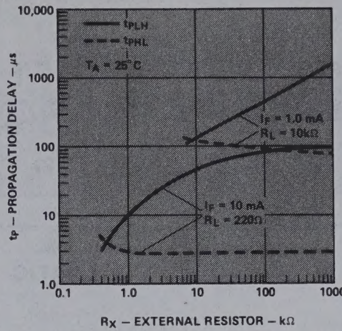
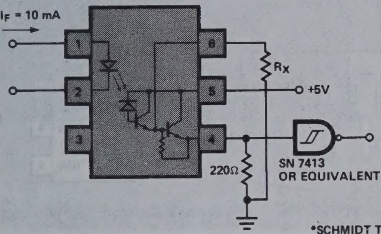


**Figure 12. Effect of $R_X$ On Propagation Delay**

## Applications

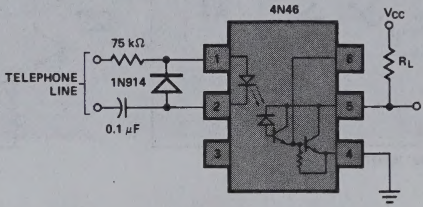


I_F = 10 mA
1
2
3
6
5
4
R_X
+5V
220Ω
SN 7413
OR EQUIVALENT*

| $R_X$ (kΩ) | $t_{PHL}$ (μs) | $t_{PLH}$ (μs) |
|---|---|---|
| ∞ | 5 | 320 |
| 100 | 5 | 200 |
| 47 | 5 | 140 |
| 20 | 6 | 80 |
| 10 | 6 | 45 |

*SCHMIDT TRIGGER RECOMMENDED BECAUSE OF LONG $t_r$, $t_f$.

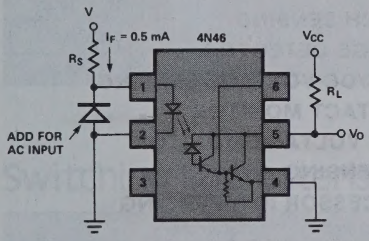
**TTL Interface**



4N46
V_CC
75 kΩ
TELEPHONE
LINE
1N914
0.1 μF
1
2
3
6
5
4
R_L
V_O

NOTE: AN INTEGRATOR MAY BE REQUIRED AT THE OUTPUT TO ELIMINATE DIALING PULSES AND LINE TRANSIENTS.

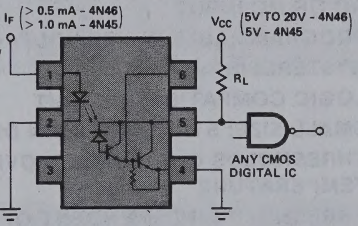
**Telephone Ring Detector**



V
I_F = 0.5 mA
4N46
V_CC
R_S
ADD FOR
AC INPUT
1
2
3
6
5
4
R_L
V_O

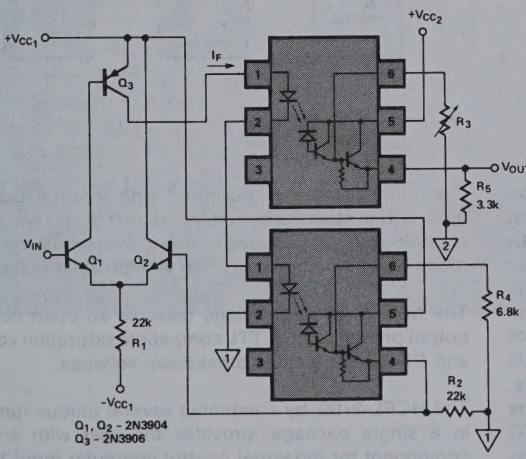
| V (Vdc or Vrms) | $R_S$ | V • $I_F$ (mW) |
|---|---|---|
| 24 | 47kΩ | 11 |
| 48 | 100kΩ | 22 |
| 115 | 220kΩ | 62 |
| 230 | 470kΩ | 113 |

**Line Voltage Monitor**



I_F (> 0.5 mA - 4N46
> 1.0 mA - 4N45)
V_CC (5V TO 20V - 4N46
5V - 4N45)
1
2
3
6
5
4
R_L
ANY CMOS
DIGITAL IC

**CMOS Interface**



+V_CC1
+V_CC2
Q_3
I_F
1
2
3
6
5
4
R_3
V_OUT
R_5
3.3k
2
V_IN
Q_1
Q_2
22k
R_1
1
-V_CC1
R_4
6.8k
R_2
22k
1
Q_1, Q_2 - 2N3904
Q_3 - 2N3906

**Analog Signal Isolation**

CHARACTERISTICS

$R_{IN} \approx 30M\Omega$, $R_{OUT} \approx 50\Omega$
$V_{IN\,(MAX.)} = V_{CC_1} - 1V$, LINEARITY BETTER THAN 5%

DESIGN COMMENTS

$R_1$ - NOT CRITICAL $\left(<< \frac{V_{IN\,(MAX.)} - (-V_{CC_1}) - V_{BE}}{I_{F\,(MAX.)}}\right) h_{FE}\ Q_3$

$R_2$ - NOT CRITICAL (OMIT IF 0.2 TO 0.3V OFFSET IS TOLERABLE)

$R_4 > \frac{V_{IN\,(MAX.)} + V_{BE}}{1\ mA}$

$R_5 > \frac{V_{IN\,(MAX.)}}{2.5\ mA}$

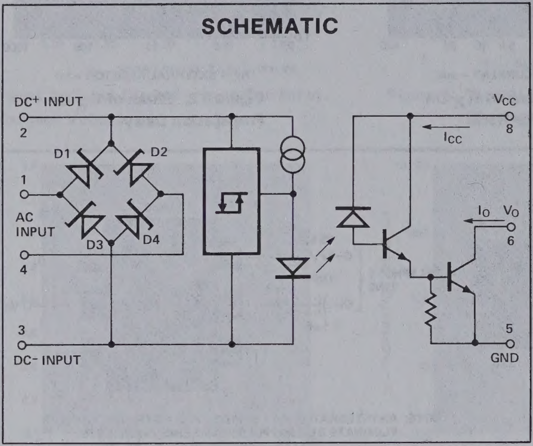
NOTE: ADJUST $R_3$ SO $V_{OUT} = V_{IN}$ AT $V_{IN} = \frac{V_{IN\,(MAX.)}}{2}$

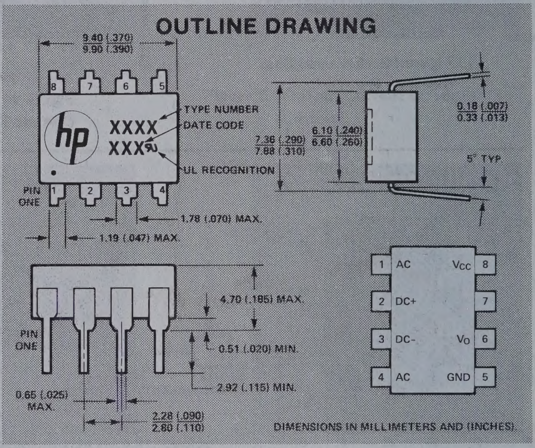
**HEWLETT PACKARD**

# AC/DC TO LOGIC INTERFACE OPTOCOUPLER

# HCPL-3700

TECHNICAL DATA FEBRUARY 1982


SCHEMATIC
DC+ INPUT
2
D1
D2
1
AC INPUT
D3
D4
4
3
DC- INPUT
VCC
8
ICC
IO
VO
6
5
GND

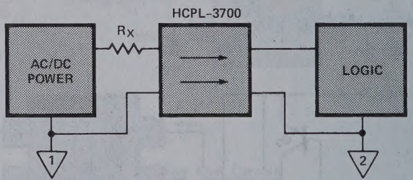

OUTLINE DRAWING
9.40 (.370)
9.90 (.390)
8 7 6 5
TYPE NUMBER
DATE CODE
XXXX
XXX
UL RECOGNITION
7.36 (.290)
7.88 (.310)
6.10 (.240)
6.60 (.260)
0.18 (.007)
0.33 (.013)
5° TYP
PIN ONE
1 2 3 4
1.78 (.070) MAX.
1.19 (.047) MAX.
4.70 (.185) MAX.
0.51 (.020) MIN.
2.92 (.115) MIN.
0.65 (.025) MAX.
2.28 (.090)
2.80 (.110)
1 AC
VCC 8
2 DC+
7
3 DC-
VO 6
4 AC
GND 5
DIMENSIONS IN MILLIMETERS AND (INCHES).

## Features

- AC OR DC INPUT
- PROGRAMMABLE SENSE VOLTAGE
- HYSTERESIS
- LOGIC COMPATIBLE OUTPUT
- SMALL SIZE: STANDARD 8 PIN DIP
- THRESHOLDS GUARANTEED OVER TEMPERATURE
- THRESHOLDS INDEPENDENT OF LED DEGRADATION
- 3000V WITHSTAND TEST VOLTAGE
- RECOGNIZED UNDER THE COMPONENT PROGRAM OF UNDERWRITERS LABORATORIES, INC. (FILE NO. E55361)

## Applications

- LIMIT SWITCH SENSING
- LOW VOLTAGE DETECTOR
- 5V—240V AC/DC VOLTAGE SENSING
- RELAY CONTACT MONITOR
- RELAY COIL VOLTAGE MONITOR
- CURRENT SENSING
- MICROPROCESSOR INTERFACING


HCPL-3700
RX
AC/DC POWER
LOGIC
1
2

## Description

The HCPL-3700 is a voltage/current threshold detection optocoupler. This optocoupler uses an internal Light Emitting Diode (LED), a threshold sensing input buffer IC, and a high gain photon detector to provide an optocoupler which permits adjustable external threshold levels. The input buffer circuit has a nominal turn on threshold of 2.5 mA ($I_{TH+}$) and 3.8 volts ($V_{TH+}$). The addition of one or more external attenuation resistors permits the use of this device over a wide range of input voltages and currents. Threshold sensing prior to the LED and detector elements minimizes effects of different optical gain and LED variations over operating life (CTR degradation). Hysteresis is also provided in the buffer for extra noise immunity and switching stability.

The buffer circuit is designed with internal clamping diodes to protect the circuitry and LED from a wide range of over-voltage and over-current transients while the diode bridge enables easy use with ac voltage input.

The high gain output stage features an open collector output providing both TTL compatible saturation voltages and CMOS compatible breakdown voltages.

The HCPL-3700, by combining several unique functions in a single package, provides the user with an ideal component for industrial control computer input boards and other applications where a predetermined input threshold optocoupler level is desirable.

## Absolute Maximum Ratings (No derating required up to 70° C)

| Parameter | | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|---|
| Storage Temperature | | $T_S$ | -55 | 125 | °C | |
| Operating Temperature | | $T_A$ | -25 | 85 | °C | |
| Lead Soldering Cycle | Temperature | | | 260 | °C | 1 |
| | Time | | | 10 | sec | |
| Input Current | Average | $I_{IN}$ | | 50 | mA | 2 |
| | Surge | | | 140 | | 2,3 |
| | Transient | | | 500 | | |
| Input Voltage (Pins 2-3) | | $V_{IN}$ | -0.5 | | V | |
| Input Power Dissipation | | $P_{IN}$ | | 230 | mW | 4 |
| Total Package Power Dissipation | | P | | 305 | mW | 5 |
| Output Power Dissipation | | $P_O$ | | 210 | mW | 6 |
| Output Current | Average | $I_O$ | | 30 | mA | 7 |
| Supply Voltage (Pins 8-5) | | $V_{CC}$ | -0.5 | 20 | V | |
| Output Voltage (Pins 6-5) | | $V_O$ | -0.5 | 20 | V | |

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Units | Note |
|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.5 | 18 | V | |
| Operating Temperature | $T_A$ | 0 | 70 | °C | |
| Operating Frequency | f | 0 | 4 | KHz | 8 |

## Switching Characteristics at $T_A = 25°$ C, $V_{CC} = 5.0$V

| Parameter | Symbol | Min. | Typ.[9] | Max. | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to Logic Low Output Level | $t_{PHL}$ | | 4.0 | 15 | µs | $R_L$ = 4.7 kΩ, $C_L$ = 30 pF | 6,9 | 10 |
| Propagation Delay Time to Logic High Output Level | $t_{PLH}$ | | 10.0 | 40 | µs | $R_L$ = 4.7 kΩ, $C_L$ = 30 pF | | 11 |
| Common Mode Transient Immunity at Logic Low Output Level | $CM_L$ | | 600 | | V/µs | $I_{IN}$ = 3.11 mA, $R_L$ = 4.7 kΩ<br>$V_{O\,max.}$ = 0.8V, $V_{CM_L}$ = 140V | 8,10 | 12,13 |
| Common Mode Transient Immunity at Logic High Output Level | $CM_H$ | | 4000 | | V/µs | $I_{IN}$ = 0 mA, $R_L$ = 4.7 kΩ<br>$V_{O\,min.}$ = 2.0V, $V_{CM_H}$ = 1400V | | |
| Output Rise Time (10-90%) | $t_r$ | | 20 | | µs | $R_L$ = 4.7 kΩ, $C_L$ = 30 pF | 7 | |
| Output Fall Time (90-10%) | $t_f$ | | 0.3 | | µs | $R_L$ = 4.7 kΩ, $C_L$ = 30 pF | | |

## Electrical Characteristics

Over Recommended Temperature (0° C ≤ $T_A$ ≤ 70° C) Unless Otherwise Specified

| Parameter | | Symbol | Min. | Typ.[9] | Max. | Units | Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|---|
| Input Threshold Current | | $I_{TH+}$ | 1.96 | 2.5 | 3.11 | mA | $V_{IN}=V_{TH+}$; $V_{CC} = 4.5V$;<br>$V_O = 0.4V$; $I_O \geq 4.2$ mA | 2,3 | 14 |
| | | $I_{TH-}$ | 1.00 | 1.3 | 1.62 | mA | $V_{IN} = V_{TH-}$ ; $V_{CC} = 4.5V$;<br>$V_O = 2.4V$; $I_{OH} \leq 100\ \mu A$ | | |
| Input Threshold Voltage | DC (Pins 2, 3) | $V_{TH+}$ | 3.35 | 3.8 | 4.05 | V | $V_{IN} = V_2 - V_3$; Pins 1 & 4 Open<br>$V_{CC} = 4.5V$; $V_O = 0.4V$;<br>$I_O \geq 4.2$ mA | | |
| | | $V_{TH-}$ | 2.01 | 2.6 | 2.86 | V | $V_{IN} = V_2 - V_3$; Pins 1 & 4 Open<br>$V_{CC} = 4.5V$; $V_O = 2.4V$;<br>$I_O \leq 100\ \mu A$ | | |
| | AC (Pins 1, 4) | $V_{TH+}$ | 4.23 | 5.1 | 5.50 | V | $V_{IN} = \|V_1 - V_4\|$; Pins 2 & 3 Open<br>$V_{CC} = 4.5V$; $V_O = 0.4V$;<br>$I_O \geq 4.2$ mA | | 14,15 |
| | | $V_{TH-}$ | 2.87 | 3.8 | 4.24 | V | $V_{IN} = \|V_1 - V_4\|$; Pins 2 & 3 Open<br>$V_{CC} = 4.5V$; $V_O = 2.4V$;<br>$I_O \leq 100\ \mu A$ | | |
| Hysteresis | | $I_{HYS}$ | | 1.2 | | mA | $I_{HYS} = I_{TH+} - I_{TH-}$ | 2 | |
| | | $V_{HYS}$ | | 1.2 | | V | $V_{HYS} = V_{TH+} - V_{TH-}$ | | |
| Input Clamp Voltage | | $V_{IHC1}$ | 5.4 | 6.0 | 6.6 | V | $V_{IHC1} = V_2 - V_3$; $V_3$ = GND;<br>$I_{IN}$ = 10 mA; Pin 1 & 4 Connected to Pin 3 | 1 | |
| | | $V_{IHC2}$ | 6.1 | 6.7 | 7.3 | V | $V_{IHC2} = \|V_1 - V_4\|$; $\|I_{IN}\|$ = 10 mA; Pins 2 & 3 Open | | |
| | | $V_{IHC3}$ | | 12.0 | 13.4 | V | $V_{IHC3} = V_2 - V_3$; $V_3$ = GND;<br>$I_{IN}$ = 15 mA; Pins 1 & 4 Open | | |
| | | $V_{ILC}$ | | -0.76 | | V | $V_{ILC} = V_2 - V_3$; $V_3$ = GND;<br>$I_{IN}$ = -10 mA | | |
| Input Current | | $I_{IN}$ | 3.0 | 3.7 | 4.4 | mA | $V_{IN} = V_2 - V_3 = 5.0V$;<br>Pins 1 & 4 Open | 5 | |
| Bridge Diode Forward Voltage | | $V_{D1,2}$ | | 0.59 | | | $I_{IN}$ = 3 mA (see schematic) | | |
| | | $V_{D3,4}$ | | 0.74 | | | | | |
| Logic Low Output Voltage | | $V_{OL}$ | | 0.1 | 0.4 | V | $V_{CC} = 4.5V$; $I_{OL}$ = 4.2 mA | 5 | 14 |
| Logic High Output Current | | $I_{OH}$ | | | 100 | μA | $V_{OH} = V_{CC} = 18V$ | | |
| Logic Low Supply Current | | $I_{CCL}$ | | 1.0 | 4 | mA | $V_2 - V_3 = 5.0V$; $V_O$ = Open<br>$V_{CC} = 5.0V$ | | |
| Logic High Supply Current | | $I_{CCH}$ | | 2 | | nA | $V_{CC} = 18V$; $V_O$ = Open | 4 | 14 |
| Input-Output Insulation Leakage Current | | $I_{I-O}$ | | | 1 | μA | Relative Humidity = 45%,<br>$T_A$ = 25° C, $V_{I-O}$ = 3000 Vdc;<br>t = 5 sec. | | 16 |
| Input-Output Resistance | | $R_{I-O}$ | | $10^{12}$ | | Ω | $V_{I-O}$ = 500 Vdc | | |
| Input-Output Capacitance | | $C_{I-O}$ | | 0.6 | | pF | f = 1 MHz, $V_{I-O}$ = 0 Vdc | | |
| Input Capacitance | | $C_{IN}$ | | 50 | | pF | f=1 MHz; $V_{IN}$=0V, Pins 2 & 3,<br>Pins 1 & 4 Open | | |

Notes:

1. Measured at a point 1.6 mm below seating plane.
2. Current into/out of any single lead.
3. Surge input current duration is 3 ms at 120 Hz pulse repetition rate. Transient input current duration is 10 μs at 120 Hz pulse repetition rate. Note that maximum input power, $P_{IN}$, must be observed.
4. Derate linearly above 70° C free-air temperature at a rate of 4.1 mW/° C. Maximum input power dissipation of 230 mW allows an input IC junction temperature of 125° C at an ambient temperature of $T_A$ = 70° C with a typical thermal resistance from junction to ambient of $\theta_{JA_i}$ = 240° C/W. Excessive $P_{IN}$ and $T_J$ may result in IC chip degradation.
5. Derate linearly above 70° C free-air temperature at a rate of 5.4 mW/° C.
6. Derate linearly above 70° C free-air temperature at a rate of 3.9 mW/° C. Maximum output power dissipation of 210 mW allows an output IC junction temperature of 125° C at an ambient temperature of $T_A$ = 70° C with a typical thermal resistance from junction to ambient of $\theta_{JA_O}$ = 265° C/W.
7. Derate linearly above 70° C free-air temperature at a rate of 0.6 mA/° C.
8. Maximum operating frequency is defined when output waveform (Pin 6) obtains only 90% of $V_{CC}$ with $R_L$ = 4.7 kΩ, $C_L$ = 30 pF using a 5V square wave input signal.

9. All typical values are at $T_A = 25°C$, $V_{CC} = 5.0V$ unless otherwise stated.
10. The $t_{PHL}$ propagation delay is measured from the 2.5V level of the leading edge of a 5.0V input pulse (1 µs rise time) to the 1.5V level on the leading edge of the output pulse (see Figure 9).
11. The $t_{PLH}$ propagation delay is measured from the 2.5V level of the trailing edge of a 5.0V input pulse (1 µs fall time) to the 1.5V level on the trailing edge of the output pulse (see Figure 9).
12. Common mode transient immunity in Logic High level is the maximum tolerable (positive) $dV_{CM/dt}$ on the leading edge of the common mode pulse, $V_{CM}$, to insure that the output will remain in a Logic High state (i.e., $V_O > 2.0V$). Common mode transient immunity in Logic Low level is the maximum tolerable (negative) $dV_{CM/dt}$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to insure that the output will remain in a Logic Low state (i.e., $V_O < 0.8V$). See Figure 10.
13. In applications where $dV_{CM/dt}$ may exceed 50,000 V/µs (such as static discharge), a series resistor, $R_{CC}$, should be included to protect the detector IC from destructively high surge currents. The recommended value for $R_{CC}$ is 240Ω per volt of allowable drop in $V_{CC}$ (between Pin 8 and $V_{CC}$) with a minimum value of 240Ω.
14. Logic low output level at Pin 6 occurs under the conditions of $V_{IN} \geq V_{TH+}$ as well as the range of $V_{IN} > V_{TH-}$ once $V_{IN}$ has exceeded $V_{TH+}$. Logic high output level at Pin 6 occurs under the conditions of $V_{IN} \leq V_{TH-}$ as well as the range of $V_{IN} < V_{TH+}$ once $V_{IN}$ has decreased below $V_{TH-}$.
15. AC voltage is instantaneous voltage.
16. Device considered a two terminal device: pins 1, 2, 3, 4 connected together, and Pins 5, 6, 7, 8 connected together.

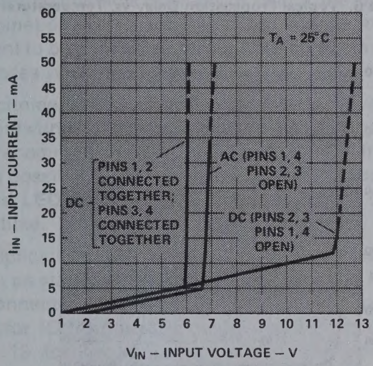


**Figure 1. Typical Input Characteristics, $I_{IN}$ vs. $V_{IN}$.**
**(AC voltage is instantaneous value.)**

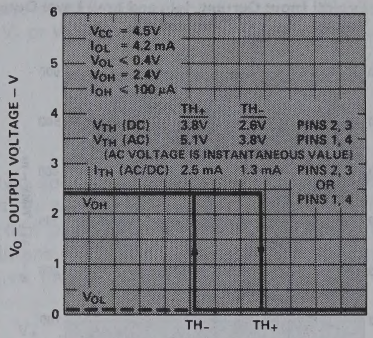


**Figure 2. Typical Transfer Characteristics.**
**(AC voltage is instantaneous value.)**

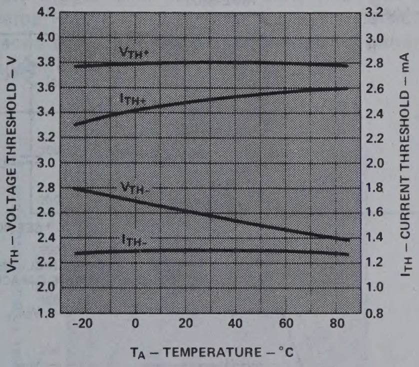


**Figure 3. Typical DC Threshold Levels vs. Temperature.**

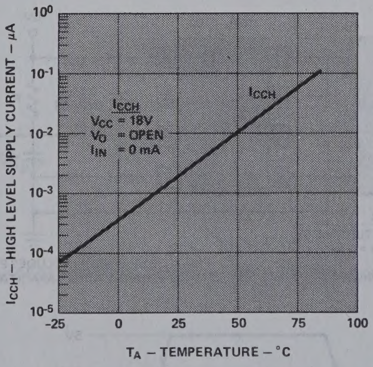


**Figure 4. Typical High Level Supply Current, $I_{CCH}$ vs. Temperature.**

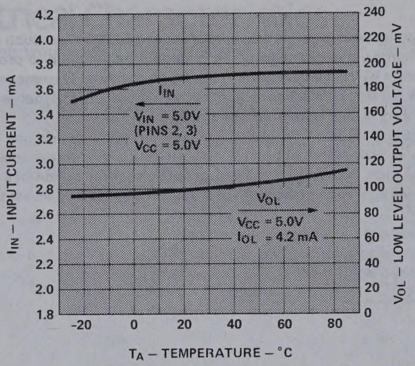


**Figure 5. Typical Input Current, $I_{IN}$, and Low Level Output Voltage, $V_{OL}$, vs. Temperature.**

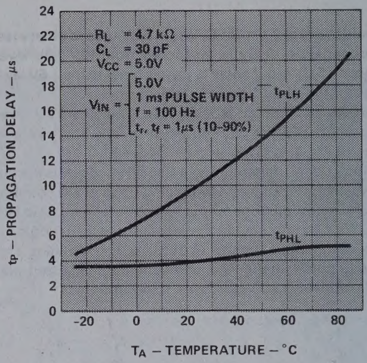


**Figure 6. Typical Propagation Delay vs. Temperature.**

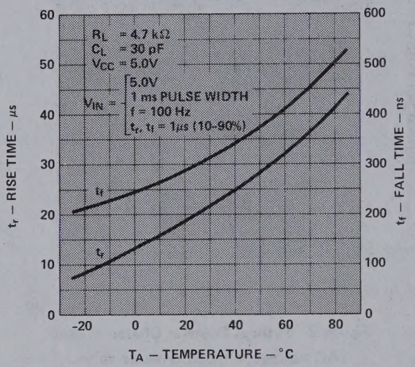


**Figure 7. Typical Rise, Fall Times vs. Temperature.**

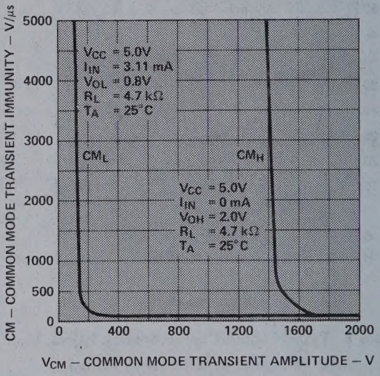
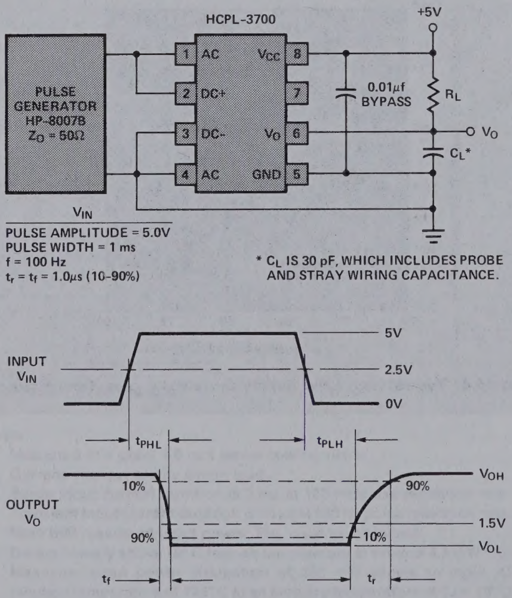


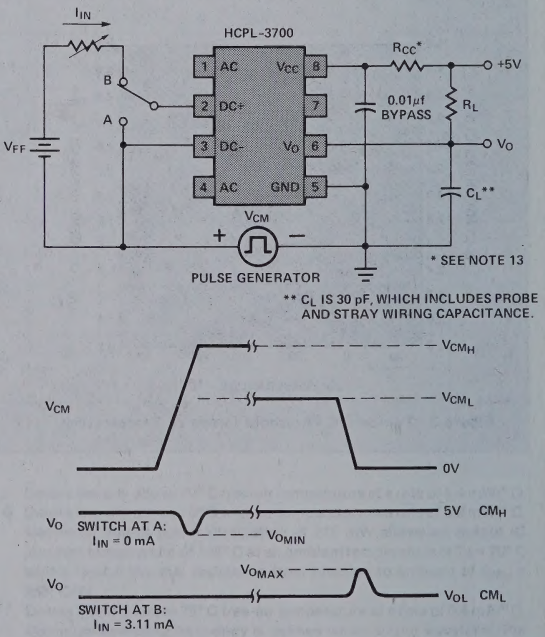
**Figure 8. Common Mode Transient Immunity vs. Common Mode Transient Amplitude.**


HCPL-3700
+5V
PULSE GENERATOR HP-8007B Z_O = 50Ω
1 AC
2 DC+
3 DC-
4 AC
V_CC 8
7
V_O 6
GND 5
0.01µf BYPASS
R_L
V_O
C_L*
V_IN
INPUT V_IN
5V
2.5V
0V
t_PHL
t_PLH
OUTPUT V_O
10%
90%
V_OH
1.5V
V_OL
90%
10%
t_f
t_r

PULSE AMPLITUDE = 5.0V
PULSE WIDTH = 1 ms
f = 100 Hz
$t_r = t_f = 1.0\mu s$ (10–90%)

* $C_L$ IS 30 pF, WHICH INCLUDES PROBE AND STRAY WIRING CAPACITANCE.

**Figure 9. Switching Test Circuit.**


I_IN
HCPL-3700
B
A
V_FF
1 AC
2 DC+
3 DC-
4 AC
V_CC 8
7
V_O 6
GND 5
R_CC*
+5V
0.01µf BYPASS
R_L
V_O
C_L**
V_CM
+
–
PULSE GENERATOR
V_CMH
V_CML
V_CM
0V
V_O
SWITCH AT A: I_IN = 0 mA
V_OMIN
5V CM_H
V_OMAX
V_O
SWITCH AT B: I_IN = 3.11 mA
V_OL CM_L

* SEE NOTE 13

** $C_L$ IS 30 pF, WHICH INCLUDES PROBE AND STRAY WIRING CAPACITANCE.

**Figure 10. Test Circuit for Common Mode Transient Immunity and Typical Waveforms.**

# Electrical Considerations

The HCPL-3700 optocoupler has internal temperature compensated, predictable voltage and current threshold points which allow selection of an external resistor, $R_x$, to determine larger external threshold voltage levels. For a desired external threshold voltage, $V_\pm$, a corresponding typical value of $R_x$ can be obtained from Figure 11. Specific calculation of $R_x$ can be obtained from Equation (1) of Figure 12. Specification of both $V_+$ and $V_-$ voltage threshold levels simultaneously can be obtained by the use of $R_x$ and $R_p$ as shown in Figure 12 and determined by Equations (2) and (3).

$R_x$ can provide over-current transient protection by limiting input current during a transient condition. For monitoring contacts of a relay or switch, the HCPL-3700 in combination with $R_x$ and $R_p$ can be used to allow a specific current to be conducted through the contacts for cleaning purposes (wetting current).

The choice of which input voltage clamp level to choose depends upon the application of this device (see Figure 1). It is recommended that the low clamp condition be used when possible to lower the input power dissipation as well as the LED current, which minimizes LED degradation over time.

In applications where $dV_{CM}/dt$ may be extremely large (such as static discharge), a series resistor, $R_{CC}$, should be connected in series with $V_{CC}$ and Pin 8 to protect the detector IC from destructively high surge currents. See note 13 for determination of $R_{CC}$. In addition, it is recommended that a ceramic disc bypass capacitor of 0.01 $\mu$f be placed between Pins 8 and 5 to reduce the effect of power supply noise.

For interfacing AC signals to TTL systems, output low pass filtering can be performed with a pullup resistor of 1.5 kΩ and 20 $\mu$f capacitor. This application requires a Schmitt trigger gate to avoid slow rise time chatter problems. For AC input applications, a filter capacitor can be placed across the DC input terminals for either signal or transient filtering.

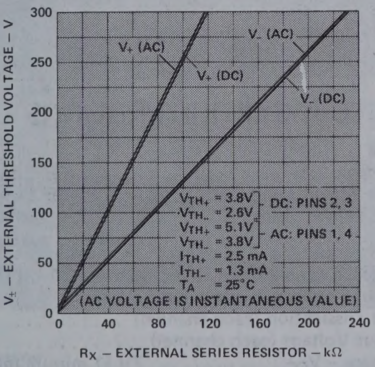


**Figure 11. Typical External Threshold Characteristic, $V_\pm$ vs. $R_X$.**

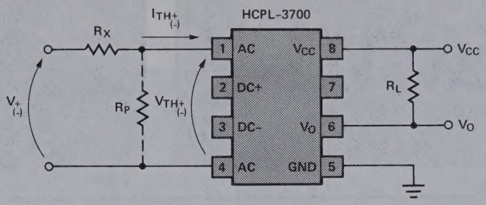


**Figure 12. External Threshold Voltage Level Selection.**

Either AC (Pins 1, 4) or DC (Pins 2, 3) input can be used to determine external threshold levels.

For one specifically selected external threshold voltage level $V_+$ or $V_-$, $R_x$ can be determined without use of $R_p$ via

$$R_x = \frac{V_{\underset{(-)}{+}} - V_{TH\underset{(-)}{+}}}{I_{TH\underset{(-)}{+}}} \qquad (1)$$

For two specifically selected external threshold voltage levels, $V_+$ and $V_-$, the use of $R_x$ and $R_p$ will permit this selection via equations (2), (3) provided the following conditions are met. If the denominator of equation (2) is positive, then

$$\frac{V_+}{V_-} \geq \frac{V_{TH+}}{V_{TH-}} \quad \text{and} \quad \frac{V_+ - V_{TH+}}{V_- - V_{TH-}} < \frac{I_{TH+}}{I_{TH-}}$$

Conversely, if the denominator of equation (2) is negative, then

$$\frac{V_+}{V_-} \leq \frac{V_{TH+}}{V_{TH-}} \quad \text{and} \quad \frac{V_+ - V_{TH+}}{V_- - V_{TH-}} > \frac{I_{TH+}}{I_{TH-}}$$

$$R_x = \frac{V_{TH-}\,(V_+) - V_{TH+}\,(V_-)}{I_{TH+}\,(V_{TH-}) - I_{TH-}\,(V_{TH+})} \qquad (2)$$

$$R_p = \frac{V_{TH-}\,(V_+) - V_{TH+}\,(V_-)}{I_{TH+}\,(V_- - V_{TH-}) + I_{TH-}\,(V_{TH+} - V_+)} \qquad (3)$$

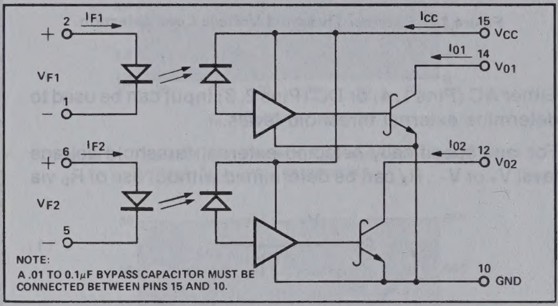
See Application Note 1004 for more information.

HEWLETT PACKARD

# DUAL CHANNEL HERMETICALLY SEALED OPTOCOUPLER

6N134
6N134 TXV
6N134 TXVB

TECHNICAL DATA FEBRUARY 1982



NOTE:
A .01 TO 0.1µF BYPASS CAPACITOR MUST BE CONNECTED BETWEEN PINS 15 AND 10.

## Features

- **HERMETICALLY SEALED**
- **HIGH SPEED**
- **PERFORMANCE GUARANTEED OVER -55°C TO +125°C AMBIENT TEMPERATURE RANGE**
- **STANDARD HIGH RELIABILITY SCREENED PARTS AVAILABLE**
- **TTL COMPATIBLE INPUT AND OUTPUT**
- **HIGH COMMON MODE REJECTION**
- **DUAL-IN-LINE PACKAGE**
- **1500 VDC WITHSTAND TEST VOLTAGE**
- **EIA REGISTRATION**
- **HIGH RADIATION IMMUNITY**

## Applications

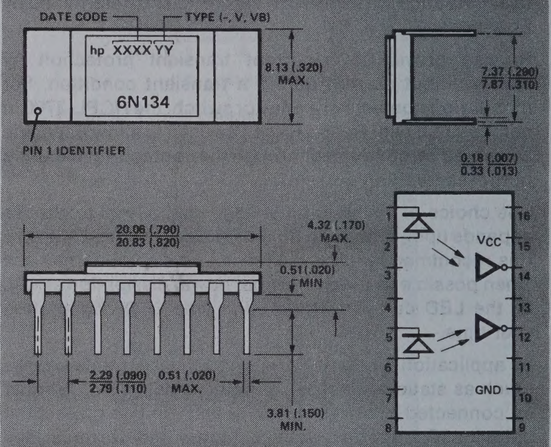
- Logic Ground Isolation
- Line Receiver
- Computer - Peripheral Interface
- Vehicle Command/Control Isolation
- High Reliability Systems
- System Test Equipment Isolation

## Description

The 6N134 consists of a pair of inverting optically coupled gates, each with a light emitting diode and a unique high gain integrated photon detector in a hermetically sealed ceramic package. The output of the detector is an open collector Schottky clamped transistor.

This unique dual coupler design provides maximum DC and AC circuit isolation between each input and output while achieving TTL circuit compatibility. The isolator operational parameters are guaranteed from -55°C to +125°C, such that a minimum input current of 10 mA in each channel will sink a six gate fanout (10 mA) at the output with 4.5 to 5.5 V $V_{CC}$ applied to the detector. This isolation and coupling is achieved with a typical propagation delay of 55 nsec.

OUTLINE DRAWING*



DIMENSIONS IN MILLIMETRES AND (INCHES).

## Recommended Operating Conditions

### TABLE I

| | Sym. | Min. | Max. | Units |
|---|---|---|---|---|
| Input Current, Low Level Each Channel | $I_{FL}$ | 0 | 250 | µA |
| Input Current, High Level Each Channel | $I_{FH}$ | 12.5** | 20 | mA |
| Supply Voltage | $V_{CC}$ | 4.5 | 5.5 | V |
| Fan Out (TTL Load) Each Channel | N | | 6 | |
| Operating Temperature | $T_A$ | −55 | 125 | °C |

## Absolute Maximum Ratings*

(No derating required up to 125°C)

| | |
|---|---|
| Storage Temperature | -65°C to +150°C |
| Operating Temperature | -55°C to +125°C |
| Lead Solder Temperature | 260°C for 10s (1.6mm below seating plane) |
| Peak Forward Input Current (each channel) | 40 mA (≤1 ms Duration) |
| Average Input Forward Current (each channel) | 20 mA |
| Input Power Dissipation (each channel) | 35 mW |
| Reverse Input Voltage (each channel) | 5V |
| Supply Voltage – $V_{CC}$ | 7V (1 minute maximum) |
| Output Current – $I_O$ (each channel) | 25 mA |
| Output Power Dissipation (each channel) | 40 mW |
| Output Voltage – $V_O$ (each channel) | 7V |
| Total Power Dissipation (both channels) | 350 mW |

**12.5mA condition permits at least 20% CTR degradation guardband. Initial switching threshold is 10mA or less.

---

*JEDEC Registered Data.

TABLE II

## Electrical Characteristics

### OVER RECOMMENDED TEMPERATURE ($T_A$ = –55°C TO +125°C) UNLESS OTHERWISE NOTED

| Parameter | Symbol | Min. | Typ.** | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| High Level Output Current | $I_{OH}$* | | 5 | 250 | $\mu$A | $V_{CC}$ = 5.5V, $V_O$ = 5.5V,<br>$I_F$ = 250$\mu$A | | 1 |
| Low Level Output Voltage | $V_{OL}$* | | 0.5 | 0.6 | V | $V_{CC}$ = 5.5V, $I_F$ = 10mA<br>$I_{OL}$ (Sinking) = 10mA | 4 | 1, 9 |
| High Level Supply Current | $I_{CCH}$* | | 18 | 28 | mA | $V_{CC}$ = 5.5V, $I_F$ = 0<br>(Both Channels) | | |
| Low Level Supply Current | $I_{CCL}$* | | 26 | 36 | mA | $V_{CC}$ = 5.5V, $I_F$ = 20mA<br>(Both Channels) | | |
| Input Forward Voltage | $V_F$* | | 1.5 | 1.75 | V | $I_F$ = 20mA, $T_A$ = 25°C | 1 | 1 |
| Input Reverse Breakdown Voltage | $BV_R$* | 5 | | | V | $I_R$ = 10$\mu$A, $T_A$ = 25°C | | |
| Input-Output Insulation Leakage Current | $I_{I\text{-}O}$* | | | 1.0 | $\mu$A | $V_{I\text{-}O}$ = 1500Vdc,<br>Relative Humidity = 45%<br>$T_A$ = 25°C, t = 5s | | 2 |
| Propagation Delay Time to High Output Level | $t_{PLH}$* | | 65 | 90 | ns | $R_L$ = 510Ω, $C_L$ = 15pF,<br>$I_F$ = 13mA, $T_A$ = 25°C | 2,3 | 5 |
| Propagation Delay Time to Low Output Level | $t_{PHL}$* | | 55 | 90 | ns | $R_L$ = 510Ω, $C_L$ = 15pF<br>$I_F$ = 13mA, $T_A$ = 25°C | 2,3 | 6 |

**All typical values are at $V_{CC}$ = 5V, $T_A$ = 25°C

TABLE III

## Typical Characteristics AT $T_A$ = 25°C, $V_{CC}$ = 5V EACH CHANNEL

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Figure | Note |
|---|---|---|---|---|---|---|---|---|
| Input Capacitance | $C_{IN}$ | | 60 | | pF | $V_F$ = 0, f = 1MHz | | 1 |
| Input Diode Temperature Coefficient | $\frac{\Delta V_F}{\Delta T_A}$ | | -1.9 | | mV/°C | $I_F$ = 20mA | | 1 |
| Resistance (Input-Output) | $R_{I\text{-}O}$ | | $10^{12}$ | | Ω | $V_{I\text{-}O}$ = 500V | | 3 |
| Capacitance (Input-Output) | $C_{I\text{-}O}$ | | 1.7 | | pF | f = 1MHz | | 3 |
| Input-Input Insulation Leakage Current | $I_{I\text{-}I}$ | | 0.5 | | nA | Relative Humidity = 45%<br>$V_{I\text{-}I}$ = 500V, t = 5s | | 4 |
| Resistance (Input-Input) | $R_{I\text{-}I}$ | | $10^{12}$ | | Ω | $V_{I\text{-}I}$ = 500V | | 4 |
| Capacitance (Input-Input) | $C_{I\text{-}I}$ | | 0.55 | | pF | f = 1MHz | | 4 |
| Output Rise-Fall Time (10-90%) | $t_r$, $t_f$ | | 35 | | ns | $R_L$ = 510Ω, $C_L$ = 15pF<br>$I_F$ = 13mA | | |
| Common Mode Transient Immunity at High Output Level | $CM_H$ | | 100 | | V/$\mu$s | $V_{CM}$ = 10V (peak),<br>$V_O$ (min.) = 2V,<br>$R_L$ = 510Ω, $I_F$ = 0mA | 6 | 7 |
| Common Mode Transient Immunity at Low Output Level | $CM_L$ | | -400 | | V/$\mu$s | $V_{CM}$ = 10V (peak),<br>$V_O$ (max.) = 0.8V<br>$R_L$ = 510Ω, $I_F$ = 10mA | 6 | 8 |

**NOTES:**

1. Each channel.
2. Measured between pins 1 through 8 shorted together and pins 9 through 16 shorted together.
3. Measured between pins 1 and 2 or 5 and 6 shorted together, and pins 9 through 16 shorted together.
4. Measured between pins 1 and 2 shorted together, and pins 5 and 6 shorted together.
5. The $t_{PLH}$ propagation delay is measured from the 6.5mA point on the trailing edge of the input pulse to the 1.5V point on the trailing edge of the output pulse.
6. The $t_{PHL}$ propagation delay is measured from the 6.5mA point on the leading edge of the input pulse to the 1.5V point on the leading edge of the output pulse.
7. $CM_H$ is the max. tolerable common mode transient to assure that the output will remain in a high logic state (i.e., $V_O > 2.0V$).
8. $CM_L$ is the max. tolerable common mode transient to assure that the output will remain in a low logic state (i.e., $V_O < 0.8V$).
9. It is essential that a bypass capacitor (.01 to 0.1$\mu$F, ceramic) be connected from pin 10 to pin 15. Total lead length between both ends of the capacitor and the isolator pins should not exceed 20mm (Fig. 7).

*JEDEC Registered Data.

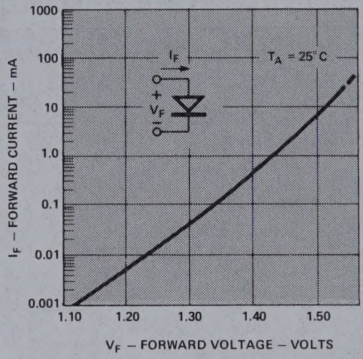
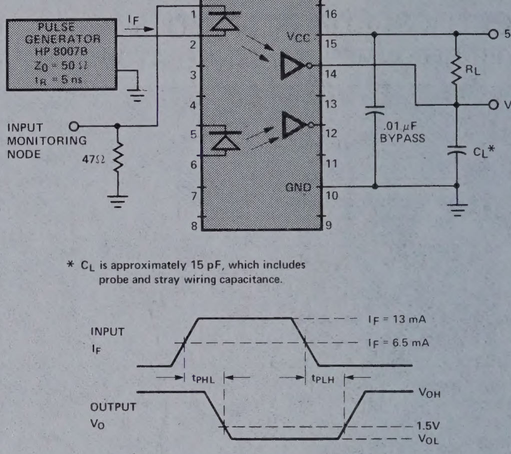


Figure 1. Input Diode Forward Characteristic


PULSE GENERATOR
HP 8007B
$Z_0 = 50\ \Omega$
$t_R = 5$ ns
$I_F$
INPUT MONITORING NODE
47Ω
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
VCC
GND
5V
$R_L$
$V_O$
.01 μF BYPASS
$C_L$*
INPUT
$I_F$
$I_F = 13$ mA
$I_F = 6.5$ mA
$t_{PHL}$
$t_{PLH}$
OUTPUT
$V_O$
$V_{OH}$
1.5V
$V_{OL}$

* $C_L$ is approximately 15 pF, which includes probe and stray wiring capacitance.

Figure 2. Test Circuit for $t_{PHL}$ and $t_{PLH}$*

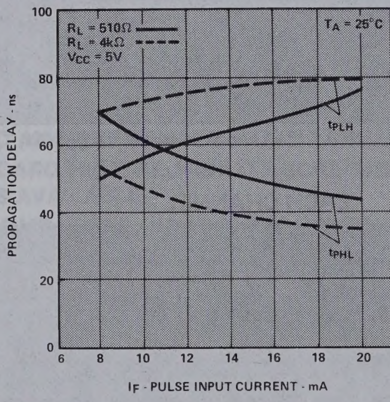


Figure 3. Propagation Delay, $t_{PHL}$ and $t_{PLH}$ vs. Pulse Input Current, $I_{FH}$

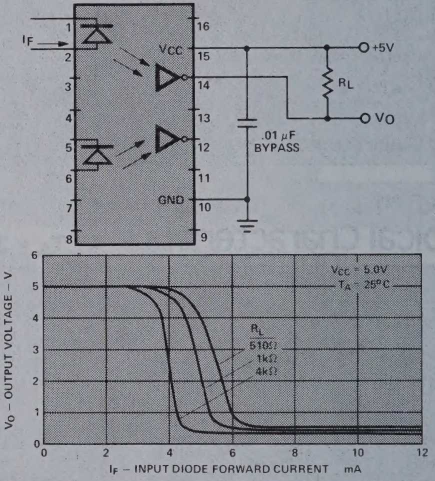


Figure 4. Input-Output Characteristics

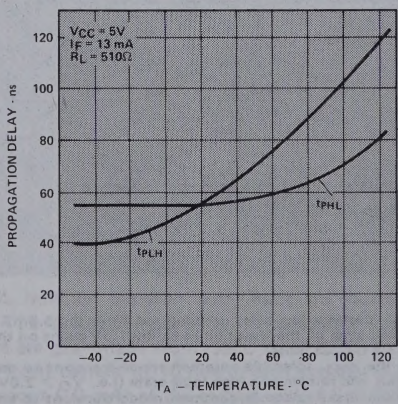


Figure 5. Propagation Delay vs. Temperature

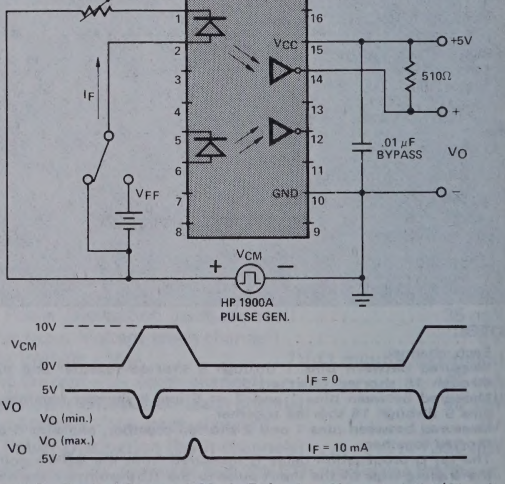

1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
VCC
GND
+5V
510Ω
+
–
$V_O$
.01 μF BYPASS
$I_F$
$V_{FF}$
$V_{CM}$
+
–
HP 1900A PULSE GEN.
10V
$V_{CM}$
0V
5V
$V_O$
$V_O$ (min.)
$I_F = 0$
$V_O$
$V_O$ (max.)
.5V
$I_F = 10$ mA

Figure 6. Typical Common Mode Rejection Characteristics/Circuit

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*JEDEC Registered Data.

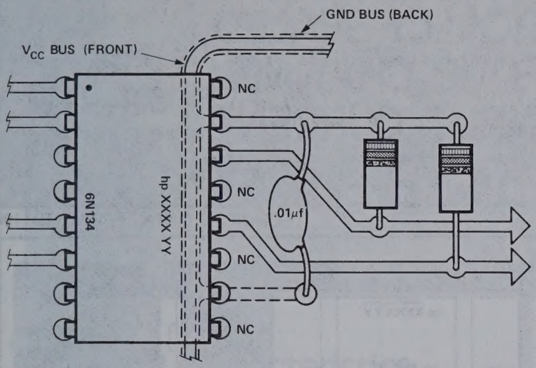


Figure 7. Recommended Circuit Board Layout.

# High Reliability Test Program

Hewlett Packard provides standard high reliability test programs, patterned after MIL-M-38510.

- The TXV suffix identifies a part which has been preconditioned and screened per Table IV.
- The TXVB suffix identifies a part which has been preconditioned and screened per Table IV, and comes from a lot which has been subjected to the Group B tests detailed in Table V.

**Part Number System**

| Commercial Product | With TX Screening | With TX Screening Plus Group B |
|---|---|---|
| 6N134 | 6N134TXV | 6N134TXVB |

## TABLE IV TXV Preconditioning and Screening —100%

| Examination or Test | MIL-STD-883 Methods | Conditions |
|---|---|---|
| 1. Pre-Cap Visual Inspection | 2010 | Condition B |
| 2. Electrical Test: $I_{OH}$, $V_{OL}$, $I_{CCH}$, $I_{CCL}$, $V_F$, $BV_R$, $I_{I-O}$ | | Per Table II, $T_A = 25°C$ |
| 3. High Temperature Storage | 1008 | 168 hrs. @ 150°C |
| 4. Temperature Cycling | 1010 | -65°C to +150°C |
| 5. Acceleration | 2001 | 5KG, $Y_1$ |
| 6. Helium Leak Test | 1014 | Test Cond. A |
| 7. Gross Leak Test | 1014 | Test Cond. C |
| 8. Electrical Test: $V_{OL}$ | | Per Table II, $T_A = 25°C$ |
| 9. Burn-In | 1015 | 168 hrs., $T_A = 125°C$,<br>$V_{CC}$=5.5V, $I_F$=13mA, $I_O$=25mA |
| 10. Electrical Test: Same as Step 2 | | |
| 11. Evaluate Drift | | Max. $\Delta V_{OL} = \pm 20\%$ |
| 12. Sample Electrical Test: $I_{OH}$, $V_{OL}$, $I_{CCH}$, $I_{CCL}$ | | Per Table II, LTPD = 7, $T_A = -55°C$ |
| 13. Sample Electrical Test: $I_{OH}$, $V_{OL}$, $I_{CCH}$, $I_{CCL}$ | | Per Table II, LTPD = 7, $T_A = +125°C$ |
| 14. Sample Electrical Test: $t_{PLH}$, $t_{PHL}$ | | Per Table II, $T_A = 25°C$, LTPD = 7 |
| 15. External Visual | 2009 | |

## TABLE V, GROUP B

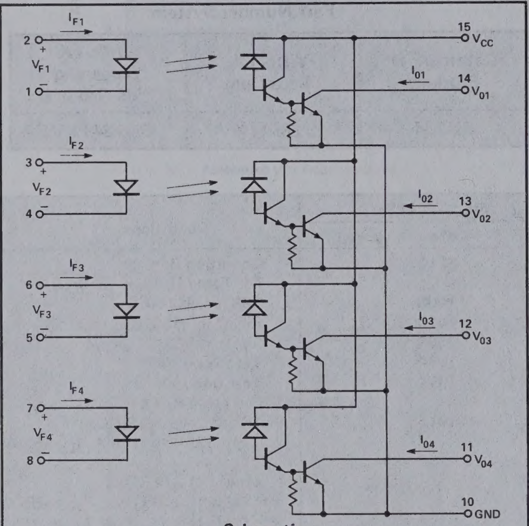
| Examination or Test | MIL-STD-883 Method | Condition | LTPD |
|---|---|---|---|
| **Subgroup 1** | | | 15 |
| Physical Dimensions | 2016 | See Product Outline Drawing | |
| **Subgroup 2** | | | 20 |
| Solderability | 2003 | Immersion within 2.5mm of body, 16 terminations | |
| **Subgroup 3** | | | 15 |
| Temperature Cycling | 1010 | Test Condition C | |
| Thermal Shock | 1011 | Test Condition A, 5 cycles | |
| Hermetic Seal, Fine Leak | 1014 | Test Condition A | |
| Hermetic Seal, Gross Leak | 1014 | Test Condition C, | |
| **End Points:** $I_{OH}$, $V_{OL}$, $I_{CCH}$, $I_{CCL}$, $V_F$, $BV_R$, $I_{I-O}$ | | Per Table II, $T_A = 25°C$ | |
| **Subgroup 4** | | | 15 |
| Shock, non-operating | 2002 | 1500 G, t = 0.5 ms, 5 blows in each orientation $X_1$, $Y_1$, $Y_2$ | |
| Constant Acceleration | 2001 | 5KG, $Y_1$ | |
| **End Points:** Same as Subgroup 3 | | | |
| **Subgroup 5** | | | 15 |
| Terminal Strength, tension | 2004 | Test Condition A, 4.5N (1 lb.), 15s | |
| **Subgroup 6** | | | |
| High Temperature Life | 1008 | $T_A = 150°C$ | $\lambda = 7$ |
| **End Points:** Same as Subgroup 3 | | | |
| **Subgroup 7** | | | |
| Steady State Operating Life | 1005 | $V_{CC} = 5.5V$, $I_F = 13mA$, $I_O = 25mA$, $T_A = 125°C$ | $\lambda = 7$ |
| **End Points:** Same as Subgroup 3 | | | |

HEWLETT PACKARD

# HERMETICALLY SEALED, FOUR CHANNEL, LOW INPUT CURRENT OPTOCOUPLER

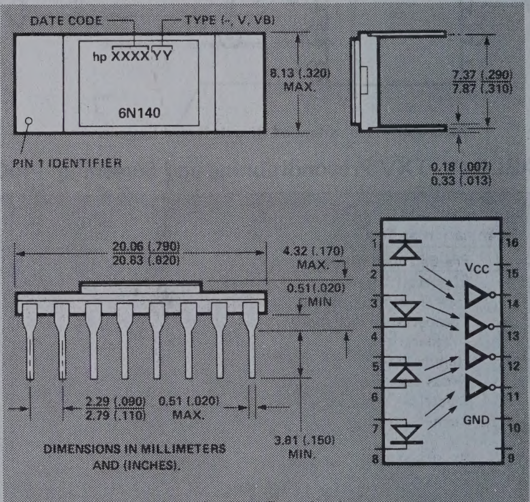
6N140
6N140TXV
6N140TXVB

TECHNICAL DATA FEBRUARY 1982



$I_{F1}$
2
$V_{F1}$
1
15 $V_{CC}$
$I_{01}$
14 $V_{01}$
$I_{F2}$
3
$V_{F2}$
4
$I_{02}$
13 $V_{02}$
$I_{F3}$
6
$V_{F3}$
5
$I_{03}$
12 $V_{03}$
$I_{F4}$
7
$V_{F4}$
8
$I_{04}$
11 $V_{04}$
10 GND

Schematic



DATE CODE
TYPE (-, V, VB)
hp XXXXYY
6N140
PIN 1 IDENTIFIER
8.13 (.320) MAX.
7.37 (.290) 7.87 (.310)
0.18 (.007) 0.33 (.013)
20.06 (.790) 20.83 (.820)
4.32 (.170) MAX.
0.51 (.020) MIN
2.29 (.090) 2.79 (.110)
0.51 (.020) MAX.
3.81 (.150) MIN.
DIMENSIONS IN MILLIMETERS AND (INCHES).
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
VCC
GND

Outline Drawing*

## Features

- HERMETICALLY SEALED
- HIGH DENSITY PACKAGING
- HIGH CURRENT TRANSFER RATIO: 500% TYPICAL
- CTR AND $I_{OH}$ GUARANTEED OVER -55°C TO 100°C AMBIENT TEMPERATURE RANGE
- STANDARD HIGH RELIABILITY SCREENED PARTS AVAILABLE
- 1500 Vdc WITHSTAND TEST VOLTAGE
- LOW INPUT CURRENT REQUIREMENT: 0.5 mA
- LOW OUTPUT SATURATION VOLTAGE: 0.1V TYPICAL
- LOW POWER CONSUMPTION
- HIGH RADIATION IMMUNITY

## Applications

- Isolated Input Line Receiver
- System Test Equipment Isolation
- Digital Logic Ground Isolation
- Vehicle Command/Control Isolation
- EIA RS-232C Line Receiver
- Microprocessor System Interface
- Current Loop Receiver
- Level Shifting
- Process Control Input/Output Isolation

## Description

The 6N140 contains four GaAsP light emitting diodes, each of which is optically coupled to a corresponding integrated high gain photon detector. A common pin for the photodiodes and first stage of each detector IC ($V_{CC}$) permits lower output saturation voltage and higher speed operation than possible with conventional photodarlington type optocouplers. Also, the separate $V_{CC}$ pin can be strobed low as an output disable or operated with supply voltages as low as 2.0V without adversely affecting the parametric performance.

The outstanding high temperature performance of this split Darlington type output amplifier results from the inclusion of an integrated emitter-base bypass resistor which shunts photodiode and first stage leakage currents to ground.

The high current transfer ratio at very low input currents permits circuit designs in which adequate margin can be allowed for the effects of CTR degradation over time.

The 6N140 has a 300% minimum CTR at an input current of only 0.5mA making it ideal for use in low input current applications such as MOS, CMOS and low power logic interfacing or RS-232C data transmission systems. Compatibility with high voltage CMOS logic systems is assured by the 18V $V_{CC}$ and by the guaranteed maximum output leakage ($I_{OH}$) at 18V.

Important specifications such as CTR, leakage current, supply current and output saturation voltage are guaranteed over the -55°C to 100°C temperature range to allow trouble free system operation.

---

* JEDEC Registered Data.

**TABLE I**

## Recommended Operating Conditions

| | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Input Current, Low Level (Each Channel) | $I_{FL}$ | | 2 | µA |
| Input Current, High Level (Each Channel) | $I_{FH}$ | 0.5 | 5 | mA |
| Supply Voltage | $V_{CC}$ | 2.0 | 18 | V |

## Absolute Maximum Ratings*

Storage Temperature .............. -65°C to +150°C
Operating Temperature ............. -55°C to +100°C
Lead Solder Temperature .............. 260°C for 10 s. (1.6mm below seating plane)
Output Current, $I_O$ (each channel) ............ 40 mA
Output Voltage, $V_O$ (each channel) ...... -0.5 to 20 V[1]
Supply Voltage, $V_{CC}$ .................. -0.5 to 20 V[1]
Output Power Dissipation (each channel) ... 50 mW[2]
Peak Input Current (each channel, ⩽1 ms duration) .......................... 20 mA
Average Input Current, $I_F$ (each channel) ..... 10 mA[3]
Reverse Input Voltage, $V_R$ (each channel) ......... 5V

**TABLE II.**

## Electrical Characteristics $T_A$ = -55°C to 100°C, Unless Otherwise Specified

| Parameter | Symbol | Min. | Typ.** | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR* | 300<br>300<br>200 | 1000<br>750<br>400 | | %<br>%<br>% | $I_F$=0.5mA, $V_O$=0.4V, $V_{CC}$=4.5V<br>$I_F$=1.6mA, $V_O$=0.4V, $V_{CC}$=4.5V<br>$I_F$=5mA, $V_O$=0.4V, $V_{CC}$=4.5V | 3 | 4,5 |
| Logic Low Output Voltage | $V_{OL}$ | | .1<br>.2 | .4<br>.4 | V<br>V | $I_F$=.5mA, $I_{OL}$=1.5mA, $V_{CC}$=4.5V<br>$I_F$=5mA, $I_{OL}$=10mA, $V_{CC}$=4.5V | 2 | 4 |
| Logic High Output Current | $I_{OH}$* | | .005 | 250 | µA | $I_F$=2µA<br>$V_O$=$V_{CC}$=18V | | 4,6 |
| Logic Low Supply Current | $I_{CCL}$* | | 2 | 4 | mA | $I_{F1}$=$I_{F2}$=$I_{F3}$=$I_{F4}$=1.6mA<br>$V_{CC}$=18V | | |
| Logic High Supply Current | $I_{CCH}$* | | .010 | 40 | µA | $I_{F1}$=$I_{F2}$=$I_{F3}$=$I_{F4}$=0<br>$V_{CC}$=18V | | |
| Input Forward Voltage | $V_F$* | | 1.4 | 1.7 | V | $I_F$=1.6mA, $T_A$=25°C | 1 | 4 |
| Input Reverse Breakdown Voltage | $BV_R$* | 5 | | | V | $I_R$=10µA, $T_A$=25°C | | 4 |
| Input-Output Insulation Leakage Current | $I_{I-O}$* | | | 1.0 | µA | 45% Relative Humidity, $T_A$=25°C, t=5s., $V_{I-O}$=1500 Vdc | | 7 |
| Propagation Delay Time To Logic High At Output | $t_{PLH}$* | | 25 | 60 | µs | $I_F$=0.5mA, $R_L$=4.7kΩ, $V_{CC}$=5.0V, $T_A$=25°C | 8 | |
| | | | 10 | 20 | µs | $I_F$=5mA, $R_L$=680Ω, $V_{CC}$=5.0V, $T_A$=25°C | 8 | |
| Propagation Delay Time To Logic Low At Output | $t_{PHL}$* | | 35 | 100 | µs | $I_F$=0.5mA, $R_L$=4.7kΩ, $V_{CC}$=5.0V, $T_A$=25°C | 8 | |
| | | | 2 | 5 | µs | $I_F$=5mA, $R_L$=680Ω, $V_{CC}$=5.0V, $T_A$=25°C | 8 | |
| Common Mode Transient Immunity At Logic High Level Output | $CM_H$ | 500 | 1000 | | V/µs | $I_F$=0, $R_L$=1.5kΩ<br>$\|V_{CM}\|$=50$V_{p-p}$, $V_{CC}$=5.0V, $T_A$=25°C | 9 | 10,12 |
| Common Mode Transient Immunity At Logic Low Level Output | $CM_L$ | -500 | -1000 | | V/µs | $I_F$=1.6mA, $R_L$=1.5kΩ<br>$\|V_{CM}\|$=50$V_{p-p}$, $V_{CC}$=5.0V, $T_A$=25°C | 9 | 11,12 |

**All typical values are at $V_{CC}$ = 5V, $T_A$ = 25°C.

**TABLE III.**

## Typical Characteristics $T_A$ = 25°C, $V_{CC}$ = 5V Each Channel

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Resistance (Input-Output) | $R_{I-O}$ | | $10^{12}$ | | Ω | $V_{I-O}$=500 Vdc, $T_A$=25°C | | 4,8 |
| Capacitance (Input-Output) | $C_{I-O}$ | | 1.5 | | pF | f=1MHz, $T_A$=25°C | | 4,8 |
| Input-Input Insulation Leakage Current | $I_{I-I}$ | | 0.5 | | nA | 45% Relative Humidity, $V_{I-I}$=500 Vdc, $T_A$=25°C, t=5s. | | 9 |
| Resistance (Input-Input) | $R_{I-I}$ | | $10^{12}$ | | Ω | $V_{I-I}$=500Vdc, $T_A$=25°C | | 9 |
| Capacitance (Input-Input) | $C_{I-I}$ | | 1 | | pF | f=1MHz, $T_A$=25°C | | 9 |
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | | -1.8 | | mV/°C | $I_F$=1.6mA | | 4 |
| Input Capacitance | $C_{IN}$ | | 60 | | pF | f=1MHz, $V_F$=0, $T_A$=25°C | | 4 |

NOTES:
1. Pin 10 should be the most negative voltage at the detector side. Keeping $V_{CC}$ as low as possible, but greater than 2.0 volts, will provide lowest total $I_{OH}$ over temperature.
2. Output power is collector output power plus one fourth of total supply power. Derate at 1.25 mW/°C above 80°C.
3. Derate $I_F$ at 0.25 mA/°C above 80°C.
4. Each channel.
5. CURRENT TRANSFER RATIO is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
6. $I_F$=2µA for channel under test. For all other channels, $I_F$=10mA.
7. Device considered a two-terminal device: Pins 1 through 8 are shorted together and pins 9 through 16 are shorted together.
8. Measured between each input pair shorted together and all output pins.
9. Measured between adjacent input pairs shorted together, i.e. between pins 1 and 2 shorted together and pins 3 and 4 shorted together, etc.
10. $CM_H$ is the maximum tolerable common mode transient to assure that the output will remain in a high logic state (i.e. $V_O > 2.0V$).
11. $CM_L$ is the maximum tolerable common mode transient to assure that the output will remain in a low logic state (i.e. $V_O < 0.8V$).
12. In applications where dV/dt may exceed 50,000 V/µs (such as a static discharge) a series resistor, $R_{CC}$, should be included to protect the detector IC's from destructively high surge currents. The recommended value is $R_{CC} \approx \frac{1V}{0.6\ I_F\ (mA)}\ k\Omega$.

*JEDEC Registered Data.

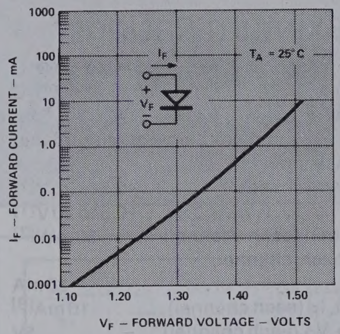


Figure 1. Input Diode Forward Current vs. Forward Voltage.

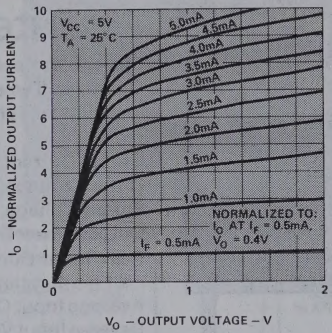


Figure 2. Normalized DC Transfer Characteristics.

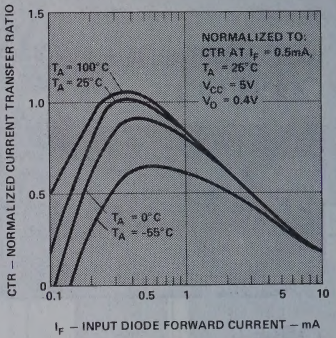


Figure 3. Normalized Current Transfer Ratio vs. Input Diode Forward Current.

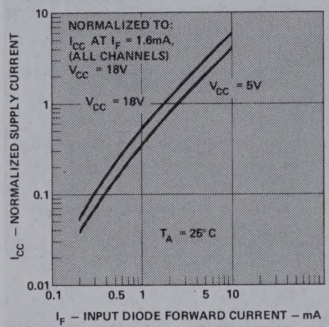


Figure 4. Normalized Supply Current vs. Input Diode Forward Current.

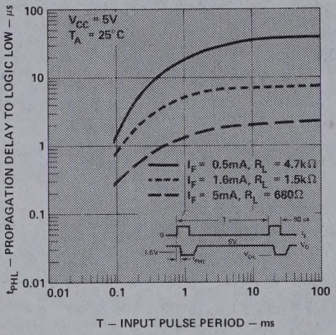


Figure 5. Propagation Delay to Logic Low vs. Input Pulse Period.

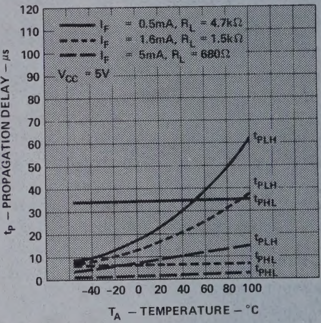


Figure 6. Propagation Delay vs. Temperature

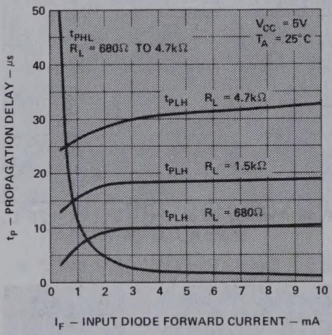


Figure 7. Propagation Delay vs. Input Diode Forward Current.

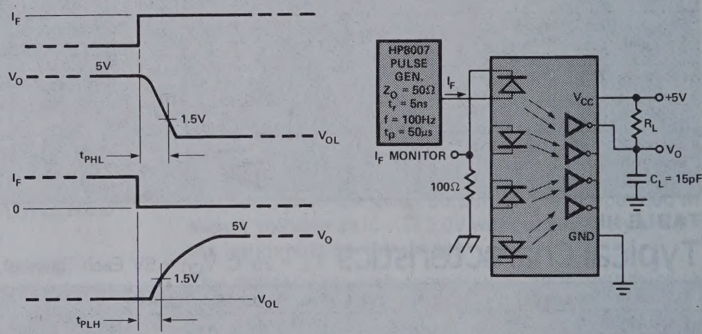

$I_F$
$V_O$
5V
1.5V
$V_{OL}$
$t_{PHL}$
$I_F$
0
5V
$V_O$
1.5V
$V_{OL}$
$t_{PLH}$
HP8007
PULSE
GEN.
$Z_O$ = 50Ω
$t_r$ = 5ns
f = 100Hz
$t_P$ = 50µs
$I_F$
$I_F$ MONITOR
100Ω
$V_{CC}$
+5V
$R_L$
$V_O$
$C_L$ = 15pF
GND

Figure 8. Switching Test Circuit.*
(f, $t_P$ not JEDEC registered)

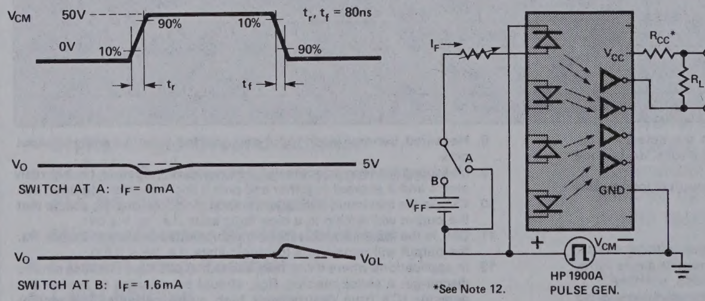

$V_{CM}$
50V
0V
10%
90%
10%
90%
$t_r$, $t_f$ = 80ns
$t_r$
$t_f$
$V_O$
5V
SWITCH AT A: $I_F$ = 0mA
$V_O$
$V_{OL}$
SWITCH AT B: $I_F$ = 1.6mA
$I_F$
A
B
$V_{FF}$
$V_{CC}$
$R_{CC}$*
+5V
$R_L$
$V_O$
GND
+
$V_{CM}$
–
HP 1900A
PULSE GEN.
*See Note 12.

Figure 9. Test Circuit for Transient Immunity and Typical Waveforms.

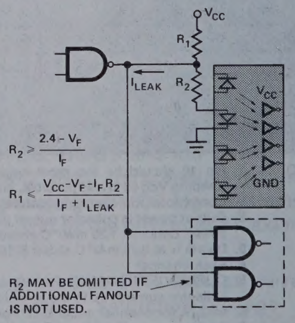

$V_{CC}$
$R_1$
$R_2$
$I_{LEAK}$
$V_{CC}$
GND
$R_2 \geq \frac{2.4 - V_F}{I_F}$
$R_1 \leq \frac{V_{CC} - V_F - I_F R_2}{I_F + I_{LEAK}}$
$R_2$ MAY BE OMITTED IF
ADDITIONAL FANOUT
IS NOT USED.

Figure 10. Recommended drive circuitry using TTL logic.

* JEDEC Registered Data.

# High Reliability Test Program

Hewlett Packard provides standard high reliability test programs, patterned after MIL-M-38510 in order to facilitate the use of HP products in military programs.

HP offers two levels of high reliability testing:

- The TXV suffix identifies a part which has been preconditioned and screened per Table IV.
- The TXVB suffix identifies a part which has been preconditioned and screened per Table IV, and comes from a lot which has been subjected to the Group B tests detailed in Table V.

**Part Number System**

| Commercial Product | With TXV Screening | With TXV Screening Plus Group B |
|---|---|---|
| 6N140 | 6N140TXV | 6N140TXVB |

**TABLE IV TXV Preconditioning and Screening — 100%**

| Examination or Test | MIL-STD-883 Methods | Conditions |
|---|---|---|
| 1. Pre-Cap Visual Inspection | 2010 | Condition B |
| 2. High Temperature Storage | 1008 | 72 hrs. @ 150°C |
| 3. Temperature Cycling | 1010 | -65°C to +150°C |
| 4. Acceleration | 2001 | 5KG, $Y_1$ |
| 5. Helium Leak Test | 1014 | Cond. A |
| 6. Gross Leak Test | 1014 | Cond. C |
| 7. Electrical Test CTR, $I_{OH}$, $I_{CCL}$, $I_{CCH}$, $V_F$, $BV_R$: | | $T_A$ = 25°C, per Table II |
| 8. Burn-In | 1015 | $V_{CC}$ = 18V, $I_F$ = 5mA, $I_O$ = 10mA<br>t = 168 hrs. @ $T_A$ = 100°C |
| 9. Electrical Test: Same as step 7 and $I_{I-O}$ | | $T_A$ = 25°C, per Table II |
| 10. Evaluate Drift | | Max. ΔCTR = ±25% @ $I_F$ = 1.6mA |
| 11. Sample Electrical Test: CTR, $I_{OH}$, $I_{CCL}$, $I_{CCH}$ | | Per Table II, LTPD = 7, $T_A$ = -55°C |
| 12. Sample Electrical Test: CTR, $I_{OH}$, $I_{CCL}$, $I_{CCH}$ | | Per Table II, LTPD = 7, $T_A$ = +100°C |
| 13. Sample Electrical Test: $t_{PHL}$, $t_{PLH}$, $CM_H$, $CM_L$ | | Per Table II, LTPD = 7, $T_A$ = 25°C |
| 14. External Visual | 2009 | |

**TABLE V, Group B**

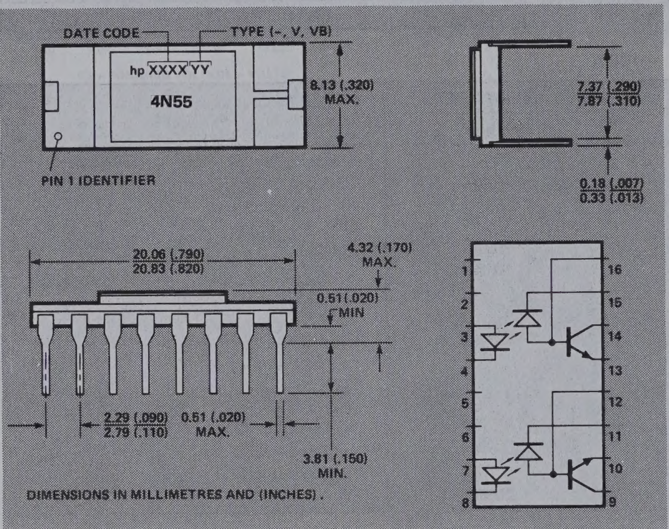
| Examination or Test | MIL-STD-883 | | LTPD |
|---|---|---|---|
| | Method | Condition | |
| **Subgroup 1** | | | |
| Physical Dimensions | 2016 | See Product Outline Drawing | 15 |
| **Subgroup 2** | | | |
| Solderability | 2003 | Immersion within 2.5mm of body, 16 terminations | 20 |
| **Subgroup 3** | | | |
| Temperature Cycling | 1010 | Test Condition C | 15 |
| Thermal Shock | 1011 | Test Condition A, 5 cycles | |
| Hermetic Seal, Fine Leak | 1014 | Test Condition A | |
| Hermetic Seal, Gross Leak | 1014 | Test Condition C | |
| **End Points:** | | | |
| CTR, $I_{OH}$, $I_{CCL}$, $I_{CCH}$, $V_F$, $BV_R$ | | Per Table II, $T_A$ = 25°C | |
| **Subgroup 4** | | | |
| Shock, non-operating | 2002 | 1500 G, t = 0.5 ms, 5 blows in each orientation $X_1$, $Y_1$, $Y_2$ | 15 |
| Constant Acceleration | 2001 | 5KG, $Y_1$ | |
| **End Points:** | | | |
| Same as Subgroup 3 | | | |
| **Subgroup 5** | | | |
| Terminal Strength, tension | 2004 | Test Condition A, 4.5N (1 lb.), 15s. | 15 |
| **Subgroup 6** | | | |
| High Temperature Life | 1008 | $T_A$ = 150°C, non-operating | $\lambda = 10$ |
| **End Points:** | | | |
| Same as Subgroup 3 | | | |
| **Subgroup 7** | | | |
| Steady State Operating Life | 1005 | $V_{CC}$ = 18V, $I_F$ = 5mA, $I_O$ = 10mA, $T_A$ = 100°C | $\lambda = 10$ |
| **End Points:** | | | |
| Same as Subgroup 3 | | | |

HEWLETT PACKARD

# DUAL CHANNEL HERMETICALLY SEALED OPTOCOUPLER

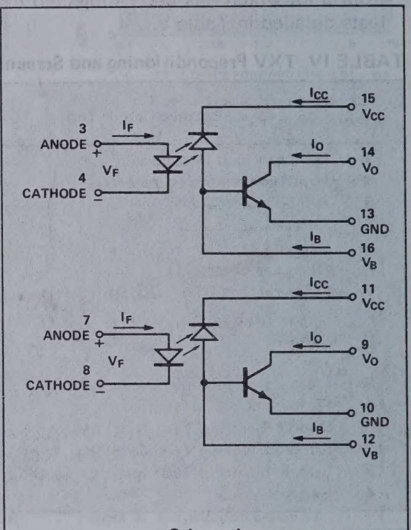
**4N55**
**4N55TXV**
**4N55TXVB**

TECHNICAL DATA FEBRUARY 1982



DATE CODE
TYPE (–, V, VB)
hp XXXX YY
4N55
8.13 (.320) MAX.
PIN 1 IDENTIFIER
7.37 (.290)
7.87 (.310)
0.18 (.007)
0.33 (.013)
20.06 (.790)
20.83 (.820)
4.32 (.170) MAX.
0.51 (.020) MIN
2.29 (.090)
2.79 (.110)
0.51 (.020) MAX.
3.81 (.150) MIN.
DIMENSIONS IN MILLIMETRES AND (INCHES).
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9

Outline Drawing



ICC
15 VCC
3 ANODE
+
IF
VF
4 CATHODE
IO
14 VO
13 GND
IB
16 VB
ICC
11 VCC
7 ANODE
+
IF
VF
8 CATHODE
IO
9 VO
10 GND
IB
12 VB

Schematic

## Features

- HERMETICALLY SEALED
- HIGH SPEED: TYPICALLY 400k bit/s
- PERFORMANCE GUARANTEED OVER -55° C TO +125° C AMBIENT TEMPERATURE RANGE
- STANDARD HIGH RELIABILITY SCREENED PARTS AVAILABLE
- 2 MHz BANDWIDTH
- OPEN COLLECTOR OUTPUTS
- 18 VOLT $V_{CC}$
- DUAL-IN-LINE PACKAGE
- 1500 Vdc WITHSTAND TEST VOLTAGE
- HIGH RADIATION IMMUNITY

## Applications

- HIGH RELIABILITY SYSTEMS
- LINE RECEIVERS
- DIGITAL LOGIC GROUND ISOLATION
- ANALOG SIGNAL GROUND ISOLATION
- SWITCHING POWER SUPPLY FEEDBACK ELEMENT
- VEHICLE COMMAND/CONTROL
- SYSTEM TEST EQUIPMENT
- LEVEL SHIFTING

## Description

The 4N55 consists of two completely isolated optocouplers in a hermetically sealed ceramic package. Each channel has a light emitting diode and an integrated photon detector providing 1500 Vdc electrical isolation between input and output. Separate connections for the photodiodes and output transistor collectors improve the speed up to a hundred times that of a conventional phototransistor optocoupler by reducing the base-collector capacitance.

The 4N55 is suitable for wide bandwidth analog applications, as well as for interfacing TTL to LSTTL or CMOS. Current Transfer Ratio (CTR) is 9% minimum at $I_F$ = 16mA over the full military operating temperature range, -55° C to +125° C. The 18V $V_{CC}$ capability will enable the designer to interface any TTL family to CMOS. The availability of the base lead allows optimized gain/bandwidth adjustment in analog applications. The shallow depth of the IC photodiode provides better radiation immunity than conventional phototransistor couplers.

# Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature | -65° C to +150° C |
| Operating Temperature | -55° C to +125° C |
| Lead Solder Temperature | 260° C for 10 s (1.6mm below seating plane) |
| Average Input Current, $I_F$ (each channel) | 20mA |
| Peak Input Current, $I_F$ (each channel, ≤ 1ms duration) | 40mA |
| Reverse Input Voltage, $V_R$ (each channel) | 5V |
| Input Power Dissipation (each channel) | 36mW |
| Average Output Current, $I_O$ (each channel) | 8mA |
| Peak Output Current, $I_O$ (each channel) | 16mA |
| Supply Voltage, $V_{CC}$ (each channel) | -0.5V to 20V |
| Output Voltage, $V_O$ (each channel) | -0.5V to 20V) |
| Emitter Base Reverse Voltage, $V_{EBO}$ | 3.0V |
| Base Current, $I_B$ (each channel) | 5mA |
| Output Power Dissipation (each channel) | 50mW |

Derate linearly above 100° C free air temperature at a rate of 1.4mW/° C.

*CAUTION: The small junction sizes inherent to the design of this bipolar component increases the component's susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.*

## TABLE I.

## Recommended Operating Conditions (EACH CHANNEL)

| | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Input Current, Low Level | $I_{FL}$ | | 250 | μA |
| Supply Voltage | $V_{CC}$ | 2 | 18 | V |

## TABLE II.

## Electrical Characteristics $T_A$ = -55° C to +125° C, unless otherwise specified

| Parameter | Symbol | Min. | Typ.* | Max. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR | 9 | 20 | | % | $I_F$=16mA, $V_O$=0.4V, $V_{CC}$=4.5V | 2,3 | 1,2 |
| Logic High Output Current | $I_{OH}$ | | 20 | 100 | μA | $I_F$=0, $I_F$ (other channel)=20mA<br>$V_O$=$V_{CC}$=18V | 4 | 1 |
| Output Leakage Current | $I_{OH1}$ | | 70 | 250 | μA | $I_F$=250μA, $I_F$ (other channel)=20mA<br>$V_O$=$V_{CC}$=18V | 4 | 1 |
| Logic Low Supply Current | $I_{CCL}$ | | 35 | 200 | μA | $I_{F1}$=$I_{F2}$=20mA, $V_{CC}$=18V | 5 | 1 |
| Logic High Supply Current | $I_{CCH}$ | | 0.2 | 10 | μA | $I_F$=0mA, $I_F$ (other channel)=20mA<br>$V_{CC}$=18V | | 1 |
| Input Forward Voltage | $V_F$ | | 1.5 | 1.8 | V | $I_F$=20mA | 1 | 1 |
| Input Reverse Breakdown Voltage | $B_{VR}$ | 3 | | | V | $I_R$=10μA | | 1 |
| Input-Output Insulation Leakage Current | $I_{I-O}$ | | | 1.0 | μA | 45% Relative Humidity,<br>$T_A$=25° C, t=5s, $V_{I-O}$=1500Vdc | | 3 |
| Propagation Delay Time to Logic High at Output | $t_{PLH}$ | | 2.0 | 6.0 | μs | $R_L$=8.2KΩ, $C_L$=50pF<br>$I_F$=16mA, $V_{CC}$=5V | 6,9 | 1 |
| Propagation Delay Time to Logic Low at Output | $t_{PHL}$ | | 0.4 | 2.0 | μs | $R_L$=8.2KΩ, $C_L$=50pF<br>$I_F$=16mA, $V_{CC}$=5V | 6,9 | 1 |

*All typical values are at $V_{CC}$ = 5V, $T_A$ = 25°C.

Notes:

1. Each channel.
2. Current Transfer Ratio is defined as the ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%. CTR is known to degrade slightly over the unit's lifetime as a function of input current, temperature, signal duty cycle and system on time. Refer to Application Note 1002 for more detail. In short it is recommended that designers allow at least 20-25% guardband for CTR degradation.
3. Measured between pins 1 through 8 shorted together and pins 9 through 16 shorted together.

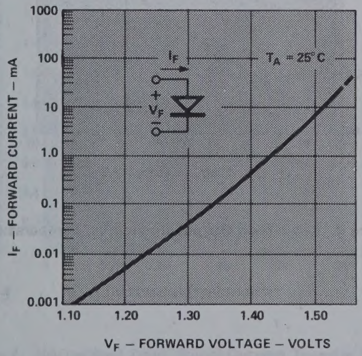


**Figure 1. Input Diode Forward Characteristic.**

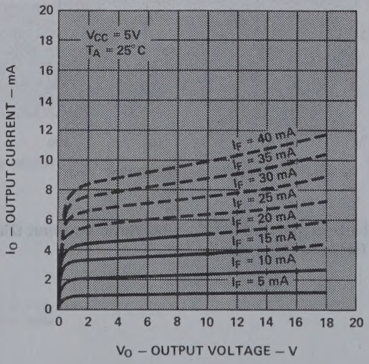


**Figure 2. DC and Pulsed Transfer Characteristic**

TABLE III.

## Typical Characteristics at $T_A = 25°C$

| Parameter | Symbol | Typ. | Units | Test Conditions | Fig. | Note |
|---|---|---|---|---|---|---|
| Temperature Coefficient of Forward Voltage | $\frac{\Delta V_F}{\Delta T_A}$ | -1.9 | mV/°C | $I_F$=18mA | | 1 |
| Input Capacitance | $C_{in}$ | 120 | pF | f=1 MHz, $V_F$=0 | | 1 |
| Resistance (Input-Output) | $R_{I-O}$ | $10^{12}$ | Ω | $V_{I-O}$=500 Vdc | | 1 |
| Capacitance (Input-Output) | $C_{I-O}$ | 1.0 | pF | f=1 MHz | | 1,4 |
| Input-Input Insulation Leakage Current | $I_{I-I}$ | 1 | pA | 45% Relative Humidity,<br>$V_{I-I}$=500Vdc, t=5s | | 5 |
| Capacitance (Input-Input) | $C_{I-I}$ | .55 | pF | f=1 MHz | | 5 |
| Transistor DC Current Gain | $h_{FE}$ | 250 | — | $V_O$=5V, $I_O$=3mA | | 1 |
| Small Signal Current Transfer Ratio | $\frac{\Delta I_O}{\Delta I_F}$ | 21 | % | $V_{CC}$=5V, $V_O$=2V | 7 | 1 |
| Common Mode Transient Immunity at Logic High Level Output | $CM_H$ | 1000 | V/μs | $I_F$=0, $R_L$=8.2kΩ<br>$V_{CM}$=10$V_{p-p}$ | 10 | 1,6 |
| Common Mode Transient Immunity at Logic Low Level Output | $CM_L$ | -1000 | V/μs | $I_F$=16mA, $R_L$=8.2kΩ<br>$V_{CM}$=10$V_{p-p}$ | 10 | 1,7 |
| Bandwidth | BW | 2 | MHz | $R_L$=100Ω | 8 | 8 |

Notes (cont.):

4. Measured between each input pair shorted together and the output pins for that channel shorted together.
5. Measured between pins 3 and 4 shorted together and pins 7 and 8 shorted together.
6. $CM_H$ is the steepest slope (dV/dt) on the leading edge of the common mode pulse, $V_{CM}$, for which the output will remain in the logic high state.
7. $CM_L$ is the steepest slope (dV/dt) on the trailing edge of the common mode pulse, $V_{CM}$, for which the output will remain in the logic low state.
8. Bandwidth is the frequency at which the ac output voltage is 3dB below the low frequency asymptote.

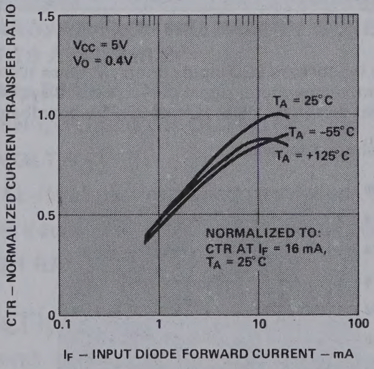


Figure 3. Normalized Current Transfer Ratio vs. Input Diode Forward Current.

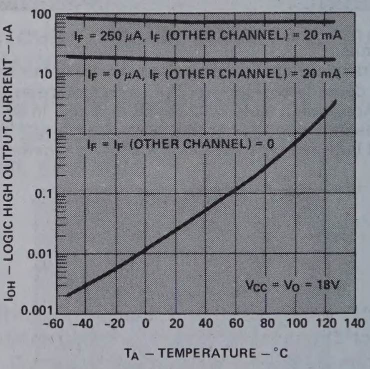


Figure 4. Logic High Output Current vs. Temperature.

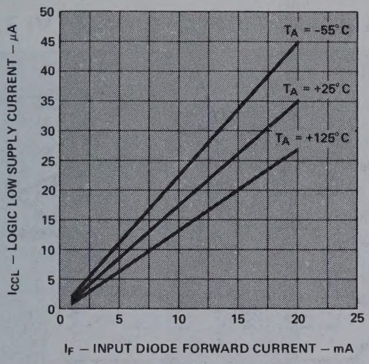


**Figure 5.** Logic Low Supply Current vs. Input Diode Forward Current.

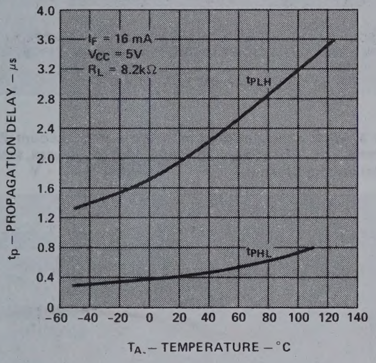


**Figure 6.** Propagation Delay vs. Temperature.

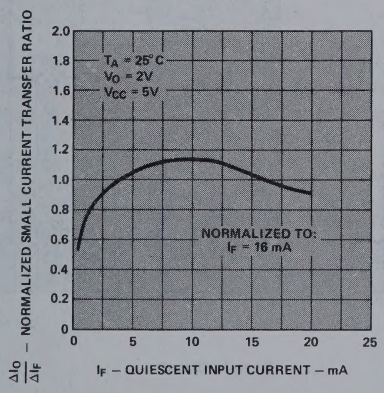


**Figure 7.** Normalized Small Signal Current Transfer Ratio vs. Quiescent Input Current.

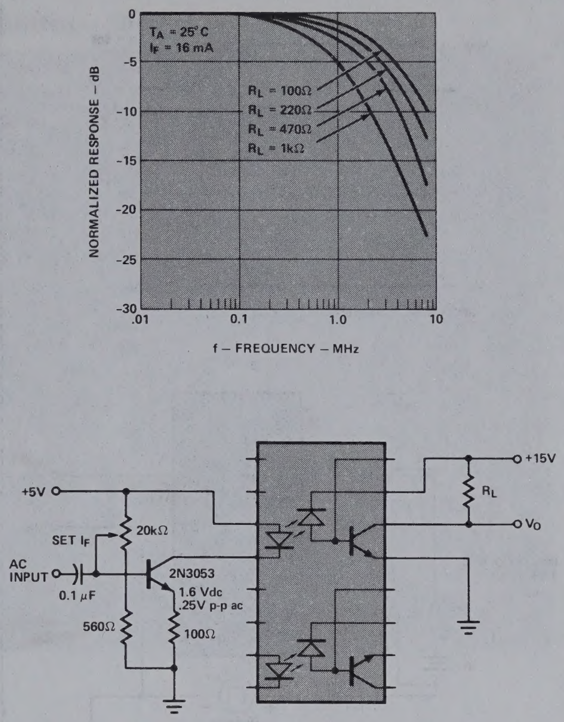


**Figure 8.** Frequency Response.

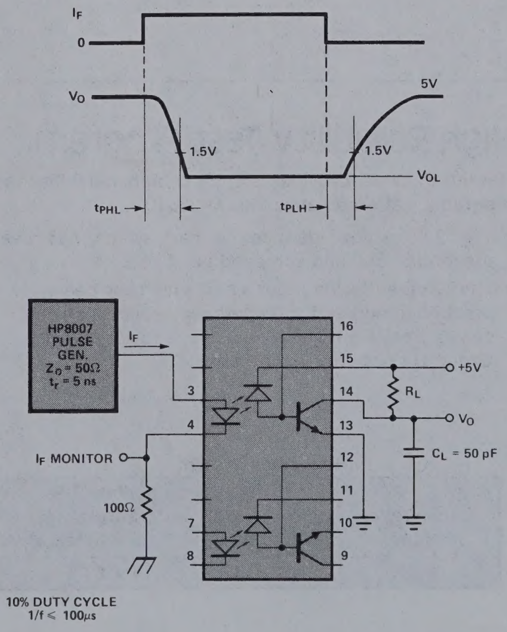

$I_F$
0
$V_O$
5V
1.5V
1.5V
$V_{OL}$
$t_{PHL}$
$t_{PLH}$
HP8007 PULSE GEN.
$Z_O$ = 50Ω
$t_r$ = 5 ns
$I_F$
3
4
7
8
16
15
14
13
12
11
10
9
+5V
$R_L$
$V_O$
$C_L$ = 50 pF
$I_F$ MONITOR
100Ω
10% DUTY CYCLE
1/f ≤ 100μs

**Figure 9.** Switching Test Circuit.

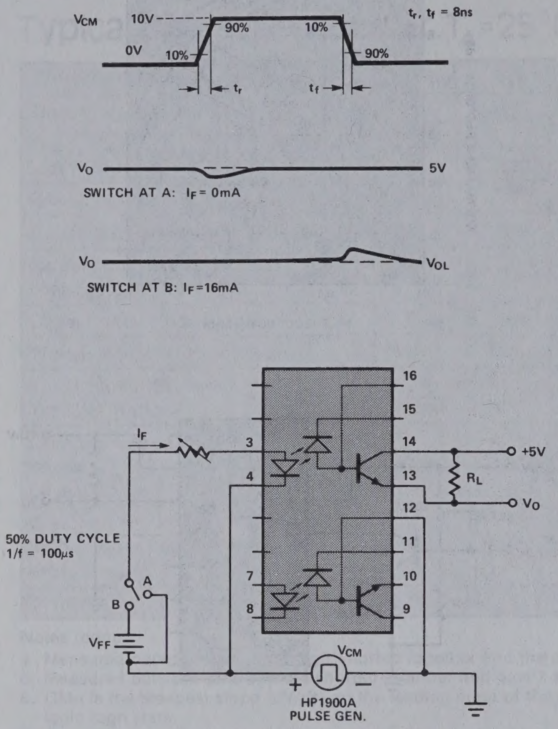
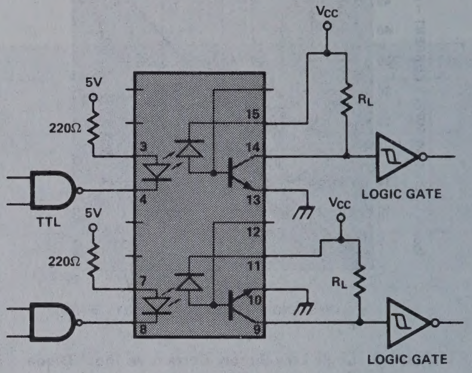

VCM
10V
0V
10%
90%
10%
90%
tr, tf = 8ns
tr
tf
VO
5V
SWITCH AT A: IF = 0mA
VO
VOL
SWITCH AT B: IF=16mA
IF
3
4
7
8
16
15
14
13
12
11
10
9
+5V
RL
VO
50% DUTY CYCLE
1/f = 100µs
A
B
VFF
VCM
+
HP1900A
PULSE GEN.

**Figure 10. Test Circuit for Transient Immunity and Typical Waveforms.**


VCC
RL
5V
220Ω
15
3
14
4
13
TTL
LOGIC GATE
VCC
5V
12
220Ω
11
7
10
RL
8
9
LOGIC GATE

| LOGIC FAMILY | LSTTL | CMOS | |
|---|---|---|---|
| DEVICE NO. | 54LS14 | CD40106BM | |
| $V_{CC}$ | 5V | 5V | 15V |
| $R_L$ 5% TOLERANCE | *18kΩ | 8.2kΩ | 22kΩ |

*THE EQUIVALENT OUTPUT LOAD RESISTANCE IS AFFECTED BY THE LSTTL INPUT CURRENT AND IS APPROXIMATELY 8.2kΩ.

This is a worst case design which takes into account 25% degradation of CTR. See App. Note 1002 to assess actual degradation and lifetime.

**Figure 11. Recommended Logic Interface.**

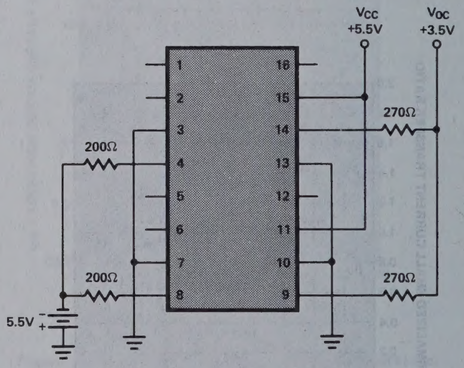
# High Reliability Test Program

Hewlett-Packard provides standard high reliability test programs, patterned after MIL-M-38510.

- The TXV suffix identifies a part which has been preconditioned and screened per Table IV.
- The TXVB suffix identifies a part which has been preconditioned and screened per Table IV, and comes from a lot which has been subjected to the Group B tests detailed in Table V.

**Part Number System**

| Commercial Product | With TXV Screening | With TXV Screening Plus Group B |
|---|---|---|
| 4N55 | 4N55TXV | 4N55TXVB |


VCC
+5.5V
VOC
+3.5V
1
2
3
4
5
6
7
8
16
15
14
13
12
11
10
9
270Ω
200Ω
200Ω
270Ω
5.5V
+

**Burn-in-Circuit**

## TABLE IV. TXV PRECONDITIONING AND SCREENING — 100%

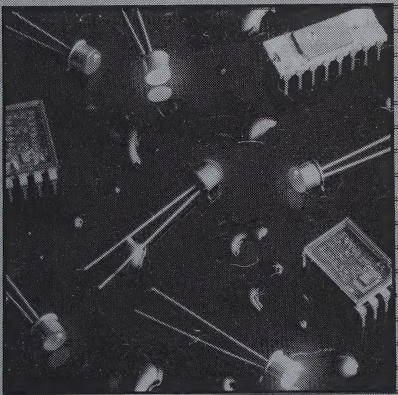
| Examination or Test | MIL-STD-883 Methods | Conditions |
|---|---|---|
| 1. Pre-Cap Visual Inspection | 2010 | Condition B |
| 2. High Temperature Storage | 1008 | 24 Hrs. @ 150°C |
| 3. Temperature Cycling | 1010 | -65°C to +150°C |
| 4. Acceleration | 2001 | 5kG, $Y_1$ |
| 5. Helium Leak Test | 1014 | Test Condition A |
| 6. Gross Leak Test | 1014 | Test Condition C |
| 7. Electrical Test: CTR | | Per Table II, $T_A = 25°C$ |
| 8. Burn-In | 1015 | 168 Hrs., $T_A = 125°C$<br>$V_{CC} = 5.5V$, $I_F = 20mA$, $V_{OC} = 3.5V$<br>$R_L = 270\Omega$ |
| 9. Electrical Test: CTR, $I_{OH}$, $I_{CCL}$, $I_{CCH}$, $V_F$, $BV_R$, $I_{I-O}$ | | Per Table II, $T_A = 25°C$ |
| 10. Evaluate Drift | | Max. $\Delta$CTR = ±20% |
| 11. Sample Electrical Test: $I_{OH}$, $I_{CCH}$, $I_{CCL}$, CTR, $V_F$, $BV_R$ | | Per Table II, LTPD = 5, $T_A = -55°C$ |
| 12. Sample Electrical Test: $I_{OH}$, $I_{CCH}$, $I_{CCL}$, CTR, $V_F$, $BV_R$ | | Per Table II, LTPD = 5, $T_A = +125°C$ |
| 13. Sample Electrical Test: $t_{PHL}$, $t_{PLH}$ | | Per Table II, $T_A = 25°C$, LTPD = 5 |
| 14. External Visual | 2009 | |

## TABLE V. GROUP B

| Examination or Test | MIL-STD-883 | | LTPD |
|---|---|---|---|
| | Method | Condition | |
| **Subgroup 1** | | | 15 |
| Physical Dimensions | 2016 | See Product Outline Drawing | |
| **Subgroup 2** | | | 20 |
| Solderability | 2003 | Immersion within 2.5mm of body, 16 terminations | |
| **Subgroup 3** | | | 15 |
| Temperature Cycling | 1010 | Test Condition C | |
| Thermal Shock | 1011 | Test Condition A | |
| Hermetic Seal, Fine Leak | 1014 | Test Condition A | |
| Hermetic Seal, Gross Leak | 1014 | Test Condition C | |
| **End Points:** $I_{OH}$, CTR, $I_{CCH}$, $I_{CCL}$, $V_F$, $BV_R$, $I_{I-O}$ | | Per Table II, $T_A = 25°C$ | |
| **Subgroup 4** | | | 15 |
| Shock, non-operating | 2002 | 1500 G, t = 0.5 ms, 5 blows in each orientation $X_1$, $Y_1$, $Y_2$ | |
| Constant Acceleration | 2001 | 5KG, $Y_1$ | |
| **End Points:** Same as Subgroup 3 | | | |
| **Subgroup 5** | | | 15 |
| Terminal Strength, tension | 2004 | Test Condition A, 4.5N (1 lb.), 15s | |
| **Subgroup 6** | | | |
| High Temperature Life | 1008 | $T_A = 150°C$, Non-operating | $\lambda = 7$ |
| **End Points:** Same as Subgroup 3 | | | |
| **Subgroup 7** | | | |
| Steady State Operating Life | 1005 | $V_{CC} = 5V$, $I_F = 20mA$, $T_A = 125°C$<br>$V_{OC} = 3.5V$, $R_L = 270\Omega$ | $\lambda = 7$ |
| **End Points:** Same as Subgroup 3 | | | |

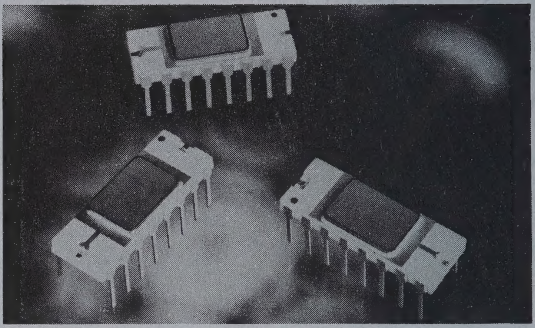
# High Reliability

- Introduction .................. 402
- Selection Guide .............. 404



## High Reliability, Military Parts

Hewlett-Packard product designs and manufacturing methods assure our ability to supply high reliability products patterned after MIL-S-19500 and MIL-M-38510 programs. Testing programs may include 100% screening tests with precap visual, lot qualification or both. Programs performed to customer drawings and specifications are available and strictly follow their control documents and procedures.

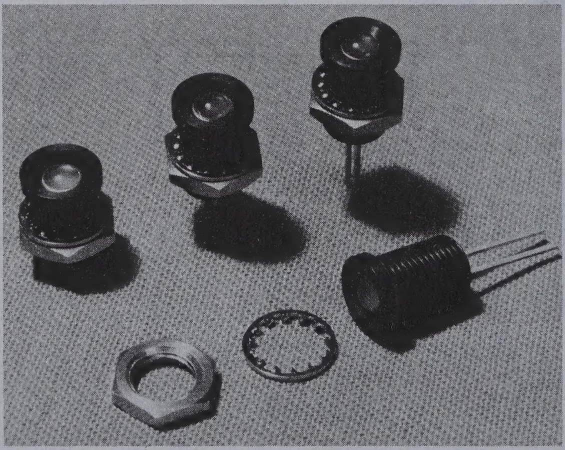


### PROGRAM CAPABILITIES

| | Available Programs* | | |
|---|---|---|---|
| **HERMETIC PRODUCTS** | **Lot Qual.** | **100% Screen** | **100% Screen and Lot Qual.** |
| Lamps Meet MIL-S-19500 | JAN | — | JANTX |
| Displays Using Hybrid Die Configuration Patterned to Class B of MIL-M-38510 | — | TXV | TXVB |
| Optocouplers Using Hybrid Die Configuration Designed Against Class B of MIL-M-38510 | — | TXV | TXVB |
| Optocouplers with Controls of MIL-M-38510 Class S | X | X | X |
| Special Optocoupler Assemblies with Testing Patterned to Class B or S of MIL-M-38510 | X | X | X |
| **NON HERMETIC PRODUCTS** | | | |
| All Products to Customer Test Programs Designed Against MIL-S-19500 or MIL-M-38510 Class B | X | X | X |

*Testing program details vary between products based on device design objectives, product history and capabilities.

— Not Available
X Available



Hewlett-Packard Components have three types of package sealing methods to meet different customer needs in the market. The recommended high reliability part is packaged in a conventional glass to glass, glass to metal seal or equivalent sealing technique using ceramic. These products are impervious to moisture and meet hermeticity testing to prescribed levels.

In addition to our hermetic products, Hewlett-Packard makes units which use an epoxy seal. These units are also capable of passing hermeticity testing and can be utilized in those high reliability applications with limited moisture exposure over long periods (Military/Industrial).

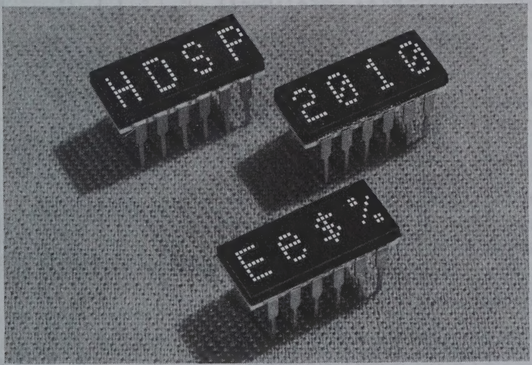
A third package type is also non-hermetic using complete epoxy encapsulation material to form both the package structure and outline. These products are often used in non man rated ground support programs and successfully pass customer lot acceptance qualification testing and 100% screening programs designed for plastic components.

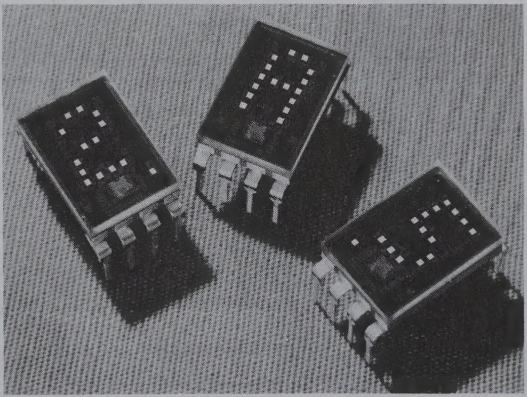
The optional tests in the following recommended screening sequence for non-hermetic devices are based on package configuration, point of assembly and customer preference. The conditions for all selected tests are product design dependent and are based on absolute maximum ratings.

## RECOMMENDED SCREENING PROGRAM FOR NON-HERMETIC DEVICES

| Test Sequence | MIL-STD-883 Method | MIL-STD-750 Method | Non-Hermetic Program |
|---|---|---|---|
| 1. Pre Cap Visual | HP Procedure | HP Procedure | Optional |
| 2. High Temperature Storage | 1008 | 1031 | 100 Percent |
| 3. Temperature Cycling | 1010 | 1051 | Optional |
| 4. Constant Acceleration | 2001 | NA | Optional |
| 5. Fine Leak | 1014 | 1071 | Optional |
| 6. Gross Leak | 1014 | 1071 | Optional |
| 7. Interim Electrical/Optical Tests | — | — | Optional |
| 8. Burn In | 1015 | 1038 | 100 Percent |
| 9. Final Electrical/Optical Tests | — | — | 100 Percent |
| 10. Delta Drift Measurements | — | — | Optional |
| 11. External Visual | 2009 | 2071 | 100 Percent |

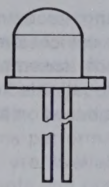
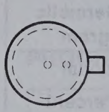
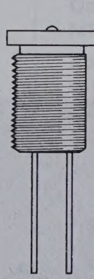
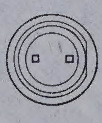
Hewlett-Packard's emphasis on reliability extends across commercial and high reliability markets. As part of our new product introduction and periodically during the life of a part, samples from typical manufacturing lots are subjected to qualification testing. The data obtained from these tests indicates reliability levels maintained by the product family and is assembled periodically into Reliability Summary data sheets. Copies may be obtained from your local Hewlett-Packard field sales office.





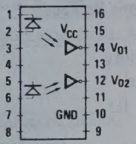
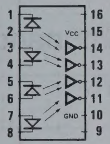
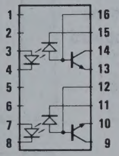
A recent addition has been made to the Department of Defense family of general specifications for semiconductor products. This new document is numbered MIL-D-87157 dated August 26, 1981 and is the military specification for solid state, Light Emitting Diode Displays. The Hewlett-Packard Company will maintain its leadership supplying state-of-the-art components for military applications by selectively qualifying our display products to slash sheets prepared in accordance with MIL-D-87157.

# Hermetically Sealed and High Reliability LED Lamps

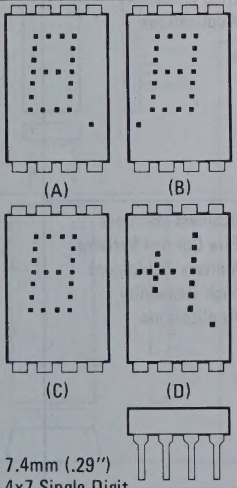
| Device | | Description | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Package Outline Drawing | Part No. | Color[2] | Package | Lens | Minimum Luminous Intensity | 2Θ½[1] | Typical Forward Voltage | Page No. |
| <br> | 1N5765<br>JAN1N5765[4]<br>JANTX1N5765[4] | Red (640 nm) | Hermetic/T0-46[3] | Red Diffused | 0.5 mcd @ 20mA | 70° | 1.6 Volts @ 20mA | 233 |
| | 1N6092<br>JAN1N6092[4]<br>JANTX1N6092[4] | High Efficiency Red (626 nm) | | | 1.0 mcd @ 20mA | | 2.0 Volts @ 20mA | |
| | 1N6093<br>JAN1N6093[4]<br>JANTX1N6093[4] | Yellow (585 nm) | | Yellow Diffused | | | | |
| | 1N6094<br>JAN1N6094[4]<br>JANTX1N6094[4] | Green (572 nm) | | Green Diffused | 0.8 mcd @ 25mA | | 2.1 Volts @ 20mA | |
| <br> | 5082-4787<br>HLMP-0930<br>HLMP-0931 | Red (640 nm) | Panel Mount Version | Red Diffused | 0.5 mcd @ 20mA | | 1.6 Volts @ 20mA | |
| | 5082-4687<br>M19500/519-01[4]<br>M19500/519-02[4] | High Efficiency Red (626 nm) | | | 1.0 mcd @ 20mA | | 2.0 Volts @ 20mA | |
| | 5082-4587<br>M19500/520-01[4]<br>M19500/520-02[4] | Yellow (585 nm) | | Yellow Diffused | | | | |
| | 5082-4987<br>M19500/521-01[4]<br>M19500/521-02[4] | Green (572 nm) | | Green Diffused | 0.8 mcd @ 25mA | | 2.1 Volts @ 20mA | |

NOTES:
1. Θ½ is the off-axis angle at which the luminous intensity is half the axial luminous intensity.
2. Peak Wavelength.
3. PC Board Mountable.
4. Military Approved and qualified for High Reliability Applications.

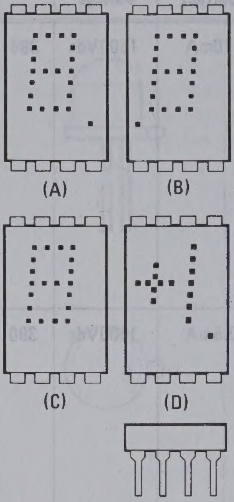
# Hermetic Optocouplers

| Device | | Description | Application | Typical Data Rate (NRZ) | Current Transfer Ratio | Specified Input Current | Withstand Test Voltage | Page No. |
|---|---|---|---|---|---|---|---|---|
|  1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>16<br>15<br>14<br>13<br>12<br>11<br>10<br>9<br>Vcc<br>VO1<br>VO2<br>GND | 6N134 | Dual Channel Hermetically Sealed Optically Coupled Logic Gate.<br>TXV – Screened<br>TXVB – Screened with Group B Data | Line Receiver, Ground Isolation for High Reliability Systems | 10M bit/s | 400% Typ. | 10mA | 1500Vdc | 386 |
| | 6N134TXV | | | | | | | |
| | 6N134TXVB | | | | | | | |
|  1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>16<br>15<br>14<br>13<br>12<br>11<br>10<br>9<br>VCC<br>GND | 6N140 | Hermetically Sealed Package Containing 4 Low Input Current, High Gain Optocouplers<br>TXV – Hi-Rel Screened<br>TXVB – Hi-Rel Screened with Group B Data | Line Receiver, Low Power Ground Isolation for High Reliability Systems | 300k bit/s | 300% Min. | 0.5mA | 1500Vdc | 390 |
| | 6N140TXV | | | | | | | |
| | 6N140TXVB | | | | | | | |
|  1<br>2<br>3<br>4<br>5<br>6<br>7<br>8<br>16<br>15<br>14<br>13<br>12<br>11<br>10<br>9 | 4N55 | Dual Channel Hermetically Sealed Analog Optical Coupler<br>TXV – Hi-Rel Screened<br>TXVB – Hi-Rel Screened with Group B Data | Line Receiver, Analog Signal Ground Isolation, Switching Power Supply Feedback Element | 700k bit/s | 7% Min. | 16mA | 1500Vdc | 394 |
| | 4N55TXV | | | | | | | |
| | 4N55TXVB | | | | | | | |

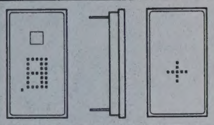
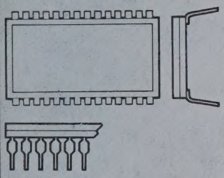
# Hermetically Sealed Integrated LED Displays

| Device | | Description | Package | Application | Page No. |
|---|---|---|---|---|---|
|  7.4mm (.29")<br>4x7 Single Digit | 4N51<br>(5082-7391)<br>4N51TXV<br>4N51TXVB<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | 8 Pin Hermetic 15.2mm (.6") DIP with gold plated leads | • Military High Reliability Applications<br>• Avionics/Space Flight Systems<br>• Fire Control Systems<br>• Ground Support, Shipboard Equipment | 144 |
| | 4N52<br>(5082-7392)<br>4N52TXV<br>4N52TXVB<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | | | |
| | 4N54<br>(5082-7395)<br>4N54TXV<br>4N54TXVB<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | | | |
| | 4N53<br>(5082-7393)<br>4N53TXV<br>4N53TXVB<br>(D) | Character Plus/Minus Sign<br>TXV – Hi Rel Screened<br>TXVB – Hi Rel Screened with Group B data | | | |

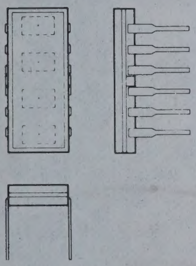
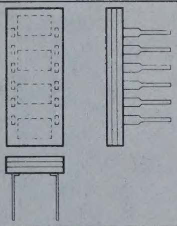
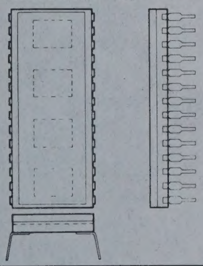
# Military/Industrial Grade Displays

| Device and Package | | Description | Color | Application | Page No. |
|---|---|---|---|---|---|
|  <br>7.4 mm (.29")<br>4 x 7 Single Digit<br>Package:<br>8 Pin Glass Ceramic<br>15.2 mm (.6") DIP | 5082-7356<br>(A) | Numeric RHDP<br>Built-in Decoder/Driver/Memory | Standard<br>Red | • Medical Equipment<br>• Industrial and Process Control Equipment<br>• Computers<br>• Where Ceramic Package IC's required<br>• High Reliability Applications | 139 |
| | 5082-7357<br>(B) | Numeric LHDP<br>Built-in Decoder/Driver/Memory | | | |
| | 5082-7359<br>(C) | Hexadecimal<br>Built-in Decoder/Driver/Memory | | | |
| | 5082-7358<br>(D) | Character Plus/Minus Sign | | | |
| | HDSP-0760<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | High Efficiency Red<br>Low Power | • Military Equipment<br>• Ground Support Equipment<br>• Avionics<br>• High Reliability<br>• Applications | 150 |
| | HDSP-0761<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0762<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0763<br>(D) | Over Range ± 1 | | | |
| | HDSP-0770<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | High Efficiency Red<br>High Brightness | • High Brightness Ambient Systems<br>• Cockpit, Shipboard Equipment<br>• High Reliability Applications | |
| | HDSP-0771<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0772<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0763<br>(D) | Over Range ± 1 | | | |
| | HDSP-0860<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | Yellow | • Business Machines<br>• Fire Control Systems<br>• Military Equipment<br>• High Relaibility Applications | |
| | HDSP-0861<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0862<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0863<br>(D) | Over Range ± 1 | | | |
| | HDSP-0960<br>(A) | Numeric RHDP<br>Built in Decoder/Driver/Memory | Green | • Business Machines<br>• Fire Control Systems<br>• Military Equipment<br>• High Reliability Applications | |
| | HDSP-0961<br>(B) | Numeric LHDP<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0962<br>(C) | Hexadecimal<br>Built in Decoder/Driver/Memory | | | |
| | HDSP-0963<br>(D) | Over Range ± 1 | | | |

## Military/Industrial Grade Displays (Cont.)

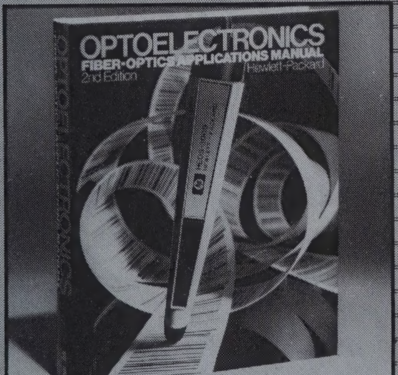
| Device | | Description | Package | Application | Page No. |
|---|---|---|---|---|---|
|  | 5082-7010 | 6.8mm (.27") 5x7 Single Digit Numeric, LHDP, Built-In Decoder/Driver | 8 Pin Metal Can 2.54mm (.100") Pin Centers | • Ground, Airborne, Shipboard Equipment<br>• Fire Control Systems<br>• Space Flight Systems | 156 |
| | 5082-7011 | 6.8mm (.27") Plus/Minus Sign | | | |
|  | 5082-7100 | 7.4mm (.29") 5x7 Three Digit Alphanumeric | 22 Pin Ceramic 15.2mm (.6") DIP | General Purpose Market<br>• Business Machines<br>• Calculators<br>• Solid State CRT<br>• High Reliability Applications<br>For further information ask for Application Note 931 on Alphanumeric Displays. | 68 |
| | 5082-7101 | 7.4mm (.29") 5x7 Four Digit Alphanumeric | 28 Pin Ceramic 15.2mm (.6") DIP | | |
| | 5082-7102 | 7.4mm (.29") 5x7 Five Digit Alphanumeric | 36 Pin Ceramic 15.2mm (.6") DIP | | |

## Alphanumeric LED Displays

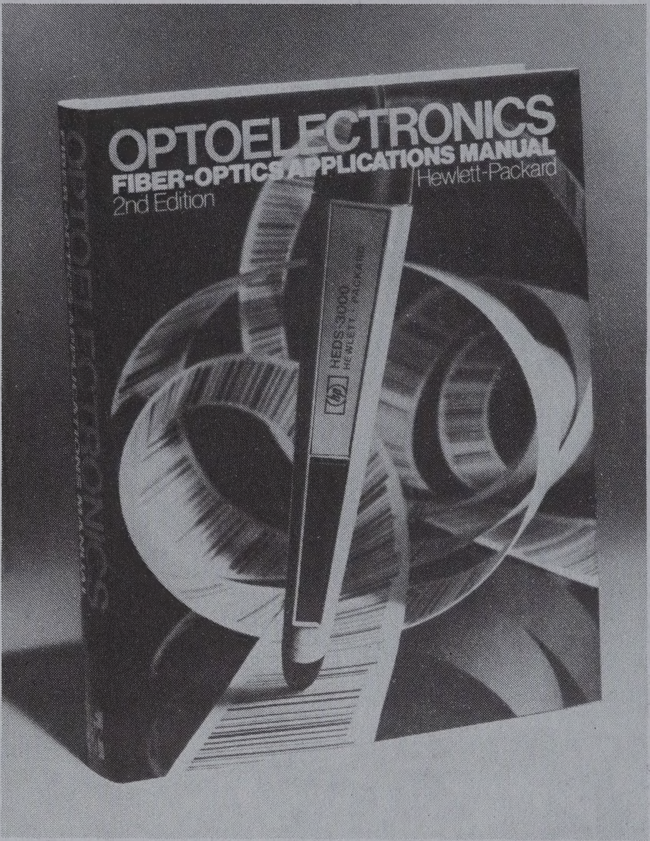
| Device | | Description | Package/ Color | Application | Page No. |
|---|---|---|---|---|---|
|  | HDSP-2000 | 3.7mm (.15") 5 x 7 Four Character Alphanumeric | 12 Pin Ceramic 7.62mm (.3") DIP/Red, Red Glass Contrast Filter | • Computer Terminals<br>• Business Machines<br>• Medical Instruments<br>• Portable, Hand-held or mobile data entry, read-out or communications<br>For further information see Application Notes 966 and 1001. | 46 |
| | HDSP-2001 | | 12 Pin Ceramic 7.62mm (.3") DIP/Yellow, Untinted Glass Lens | | |
| | HDSP-2002 | | 12 Pin Ceramic 7.62mm (.3") DIP/High Eff. Red, Untinted Glass Lens | | |
| | HDSP-2010 | Extended Temperature to $T_A = -40^\circ C$<br>3.7mm (.15") 5 x 7 Four Character Alphanumeric | 12 Pin Ceramic 7.62mm (.3") DIP/Red, Red Glass Contrast Filter | • Extended temperature applications requiring high reliability.<br>• I/O Terminals<br>• Avionics<br>For further information see Application Notes 966 and 1001. | 52 |
| | 2010TXV | TXV Hi Rel Screened | | | |
|  | HDSP-2300 | 4.87mm (.19") 5 x 7 Four Character Alphanmeric | 12 Pin Ceramic 6.35mm (.25") DIP/Red, Low Power | • Avionics<br>• Military Equipment<br>• Ground Support, Cockpit, Shipboard systems<br>• Medical Equipment<br>• Industrial and Process control<br>• Computer Peripherals and Terminals<br>• Outdoor Metering Equipment<br>• Computer Base Mobile Units<br>• High Brightness Ambient Systems<br>For further information see Application Notes 966 and 1001. | 56 |
| | HDSP-2301 | | 12 Pin Ceramic 6.35mm (.25") DIP/Yellow, High Brightness | | |
| | HDSP-2302 | | 12 Pin Ceramic 6.35mm (.25") DIP/High Eff. Red, High Brightness | | |
|  | HDSP-2490 | 6.9mm (.27") 5 x 7 Four Character Alphanumeric | 28 Pin Ceramic 15.24mm (.6") DIP/ Red | | 62 |
| | HDSP-2491 | | 25 Pin Ceramic 15.24mm (.6") DIP/ Yellow, High Brightness | | |
| | HDSP-2492 | | 25 Pin Ceramic 15.24mm (.6") DIP/ High Eff. Red, High Brightness | | |

# Applications Information

- Application Bulletins, Notes, and Manual Listings .......... 411
- Abstracts .................... 412


OPTOELECTRONICS
FIBER-OPTICS APPLICATIONS MANUAL
2nd Edition
Hewlett-Packard

# Applications

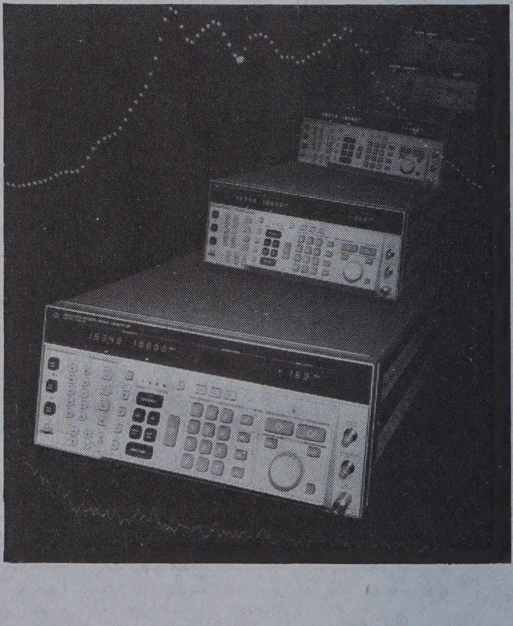


### (HPBK-2000) OPTOELECTRONICS/ FIBER-OPTICS APPLICATIONS MANUAL

A vastly expanded version of the original Optoelectronics Applications Manual published by McGraw-Hill in 1977, this new edition provides the electronic engineer with up to date design techniques on state of the art optoelectronic products. Added to the original extensive coverage of LED's, Displays, and Optocouplers is a new wealth of information on Fiber Optics, Industrial Uses of Optocouplers, Back Lighting, Interfacing displays to Microprocessors, Sunlight Viewable displays, and Precision reflective optical position sensing.

This book can be purchased from a Hewlett-Packard franchised distributor or from the McGraw-Hill Publishing Company. A complete listing of all HP Components authorized distributors can be found on pages 418-420.

Hewlett-Packard's 5082-7300 dot matrix display was chosen by HP's Stanford Park division for use in their highly sophisticated low noise signal generator, the 8662. This low noise signal generator was designed to have extremely low RFI and spurious emission. As a result, it was necessary to pay extreme attention to potential RFI and to find a display that did not require strobing. The 5082-7300, with its on board electronics, satisfied this requirement and provided an aesthetic front panel display.



*Below is a complete listing of all the Optoelectronic Applications Information available. A brief abstract of each Application Note is shown. These are available in their entirety from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.*

## APPLICATION BULLETINS

| Model/Pub. No. (Date) | Description |
|---|---|
| AB-1/5952-8378 (1/75) | Construction and Performance of High Efficiency Red, Yellow and Green LED Materials |
| AB-3/5952-8380 (3/75) | Soldering Hewlett-Packard Silver Plated Lead Framed LED Devices |
| AB-4/5952-8381 (4/75) | Detection and Indication of Segment Failures in 7-Segment LED Displays |
| AB-52/5953-0330 (3/77) | Large Monolithic LED Displays |
| AB-54/5953-0363 (7/77) | Mechanical Handling of Subminiature LED Lamps and Arrays |
| AB-56/5953-0415 (11/79) | Interface Timing and Display Length Expansion Information for the HDSP-2000 Coded Data Controller |
| AB-57/5953-0418 (1/80) | Flux Budget Considerations for Fiber Optic Link Design |

## APPLICATION NOTES

| Model/Pub. No. (Date) | Description |
|---|---|
| AN-915/5953-0431 (4/80) | Threshold Detection of Visible and Infrared Radiation with PIN Photodiodes |
| AN-931/5952-0235 (11/70) | Solid State Alphanumeric Display, Decoder/Driver Circuitry |
| AN-934/5952-0337 (11/72) | 5082-7300 Series Solid State Display Installation Techniques |
| AN-937/5952-0396 (5/73) | Monolithic 7-Segment LED Display Installation Techniques |
| AN-939/5952-0331 (11/72) | High Speed Optically Coupled Isolators |
| AN-945/5952-0420 (10/73) | Photometry of Red LEDs |
| AN-946/5952-0429 (11/73) | 5082-7430 Series Monolithic 7-Segment Displays |
| AN-947/5952-8497 (7/76) | Digital Data Transmission Using Optically Coupled Isolators |
| AN-948/5952-0458 (3/74) | Performance of the 5082-4350/51/60 Series of Isolators in Short to Moderate Length Digital Data Transmission Systems |
| AN-951-1/5953-0413 (11/79) | Applications for Low Input Current, High Gain Optically Coupled Isolators |
| AN-951-2/5952-8451 (5/76) | Linear Applications of Optically Coupled Isolators |
| AN-964/5952-8345 (3/75) | Contrast Enhancement Techniques |

## APPLICATION NOTES (Cont'd.)

| Model/Pub. No. (Date) | Description |
|---|---|
| AN-966/5953-0427 (2/80) | Applications of the HDSP-2000 Alphanumeric Display |
| AN-1000/5953-0391 (11/78) | Digital Data Transmission with the HP Fiber Optic System |
| AN-1001/5953-0384 (10/78) | Interfacing the HDSP-2000 to Microprocessor Systems |
| AN-1002/5953-0385 (6/79) | Consideration of CTR Variations in Optically Coupled Isolator Circuit Designs |
| AN-1003/5953-0405 (9/79) | Interfacing 18-Segment Displays to Microprocessors |
| AN-1004/5953-0406 (11/79) | Threshold Sensing for Industrial Control Systems with the HCPL-3700 Interface Optocoupler |
| AN-1005/5953-0419 (3/80) | Operational Considerations for LED Lamps and Display Devices |
| AN-1006/5953-0439 (7/80) | Seven Segment LED Display Applications |
| AN-1007/5953-0452 (1/81) | Bar Graph Array Applications |
| AN-1008/5953-0460 (12/80) | Optical Sensing with the HEDS-1000 |
| AN-1009/5953-0455 (11/80) | Designing with the HFBR-0500 Series Snap-in Fiber-Optic Link |
| AN-1011/5953-0482 (4/81) | Design and Operational Considerations for the HEDS-5000 Incremental Shaft Encoder |
| AN-1012/5953-0478 (2/81) | Methods of Legend Fabrication |

## APPLICATIONS MANUAL

| Model/Pub. No. (Date) | Description |
|---|---|
| HPBK-2000<br>McGraw-Hill<br>(No. 93203815)<br>(1981) | Optoelectronics/Fiber-Optics Applications Manual |

# Abstracts

### APPLICATION BULLETIN 1
### Construction and Performance of High Efficiency Red, Yellow and Green LED Materials

The high luminous efficiency of Hewlett-Packard's High Efficiency Red, Yellow and Green lamps and displays is made possible by a new kind of light emitting material utilizing a GaP transparent substrate. This application bulletin discusses the construction and performance of this material as compared to standard red GaAsP and red GaP materials.

### APPLICATION BULLETIN 3
### Soldering Hewlett-Packard Silver Plated Lead Frame LED Devices

Many of Hewlett-Packard's commercial LED devices use a silver plated lead frame. Soldering to a silver lead frame provides a reliable electrical and mechanical connection and is no more complicated than soldering to a gold lead frame. Some suggestions on how to handle and solder silver plated lead frame devices are presented.

### APPLICATION BULLETIN 4
### Detection and Indication of Segment Failures in Seven Segment LED Displays

The occurrence of a segment failure in certain applications of seven segment displays can have serious consequences if a resultant erroneous message is read by the viewer. This application bulletin discusses three techniques for detecting open segment lines and presenting this information to the viewer.

### APPLICATION BULLETIN 52
### Large Monolithic LED Displays

The trend to incorporate more complex functions into smaller package configurations that are portable and battery powered is reaching a point where the limiting items are the space and power constraints imposed upon the display at the operator-to-machine interface. The large monolithic LED display has been designed to meet many of these constraints. This application bulletin describes the beneficial features of a large monolithic LED display and presents circuits which interface the display to CMOS logic and to a microprocessor.

### APPLICATION BULLETIN 54
### Mechanical Handling of Subminiature LED Lamps and Arrays

#### The Need for Careful Mechanical Handling

Hewlett-Packard manufactures a series of individual LED lamps and lamp arrays that are very small epoxy encapsulated devices. These devices are classified as having a SUBMINIATURE package configuration. When carefully installed on a printed circuit board, these devices will reliably function with a long predictable operating life.

To obtain long operating life, these subminiature devices must be carefully installed on the printed circuit board in such a manner as to insure the integrity of the encapsulating epoxy. This will in turn maintain the integrity of the device by not permitting mechanical and thermal stresses to induce strains on the LED die attach and wire bonds which may cause failure.

This application bulletin describes the subminiature package assembly, the package's mechanical limitations and offers specific suggestions for proper installation.

### APPLICATION BULLETIN 56
### Interface Timing and Display Length Expansion Information for the HDSP-2000 Coded Data Controller

The HDSP-2000 CODED DATA CONTROLLER described in application note 1001 is a versatile circuit, easily modified to multiplex any display length. This application bulletin contains the key timing information and a detailed explanation of how the circuit operates. With this information, it should be a straightforward exercise to expand the display to any desired length. Included in this application bulletin are designs for 32, 64, and 128 character displays.

# Abstracts

## APPLICATION BULLETIN 57
### Flux Budget Considerations for Fiber Optic Link Design

This application bulletin is intended to supplement application note 1000. Basic information on flux budgeting with specific examples using the Hewlett-Packard HFBR-1002 Fiber Optic Transmitter, HFBR-2001 Fiber Optic Receiver, and HFBR-3000 Series Fiber Optic Cable/Connector Assemblies is presented. To determine the performance of a fiber optic system, three main areas must be considered: Transmitter Output Optical Flux, Receiver Input Sensitivity, and System Insertion Losses. When designing a fiber optic system, an analysis that includes temperature, humidity, and voltage variations will require using the minimum transmitter output flux and corresponding minimum receiver input sensitivity to ensure the performance of the fiber optic system for the environmental conditions of the system.

## APPLICATION NOTE 915
### Threshold Detection of Visible and Infrared Radiation with PIN Photodiodes

PIN photodiodes are compared with multiplier phototubes in an 11-point summary of their relative merits. This is followed by a description of PIN photodiode device structure, mode of operation, and analysis of the diode's equivalent circuit.

Four pre-amplifier circuits are presented. Two of these describe use of operational amplifiers — one for linear response, the other for logarithmic response. The other two circuits are designed for substantially higher speeds of response, using discrete components to obtain wide bandwidth as well as high sensitivity.

## APPLICATION NOTE 931
### Solid State Alphanumeric Display...Decoder/Driver Circuitry

Hewlett-Packard offers a series of solid state displays capable of producing multiple alphanumeric characters utilizing 5 x 7 dot arrays of GaAsP light emitting diodes (LED's). These 5 x 7 dot arrays exhibit clear, easily read characters. In addition, each array is X-Y addressable to allow for a simple addressing, decoding, and driving scheme between the display module and external logic.

Methods of addressing, decoding and driving information to such an X-Y addressable matrix are covered in detail in this application note. The note starts with a general definition of the scanning or strobing technique used for this simplified addressing and then proceeds to describe horizontal and vertical strobing. Finally, a detailed circuit description is given for a practical vertical strobing application.

## APPLICATION NOTE 934
### 5082-7300 Series Solid State Display Installation Techniques

The 5082-7300 series Numeric/Hexadecimal indicators are an excellent solution to most standard display problems in commercial, industrial and military applications. The unit integrates the display character and associated drive electronics in a single package. This advantage allows for space, pin and labor cost reductions, at the same time improving overall reliability.

The information presented in this note describes general methods of incorporating the -7300 into varied applications.

## APPLICATION NOTE 937
### Monolithic Seven Segment LED Display Installation Techniques

The Hewlett-Packard series of small end-stackable monolithic GaAsP displays are designed for strobing, a drive method that allows time sharing of the character generator among the digits in a display.

This Application Note begins with an explanation of the strobing technique, followed by a discussion of the uses and advantages of the right hand and center decimal point products.

Several circuits are given for typical applications. Finally, a discussion of interfacing to various data forms is presented along with comments on mounting the displays.

# Abstracts

## APPLICATION NOTE 939
### High Speed Optically Coupled Isolators

Often designers are faced with the problem of providing circuit isolation in order to prevent ground loops and common mode signals. Typical devices for doing this have been relays, transformers and line receivers. However, both relays and transformers are low speed devices, incompatible with modern logic circuits. Line receiver circuits are fast enough, but are limited to a common mode voltage of 3 volts.

In addition, they do not protect very well against ground loop signals. Now Optically Coupled Isolators are available which solve most isolation problems.

This Application Note contains a description of Hewlett-Packard's high speed isolators, and discusses their applications in digital and analog systems.

## APPLICATION NOTE 945
### Photometry of Red LEDs

Nearly all LEDs are used either as discrete indicator lamps or as elements of a segmented or dot-matrix display. As such, they are viewed directly by human viewers, so the primary criteria for determining their performance is the judgment of a viewer. Equipment for measuring LED light output should, therefore, simulate human vision.

This Application Note will provide answers to these questions:

1. What to measure (definitions of terms)
2. How to measure it (apparatus arrangement)
3. Whose equipment to use (criteria for selection)

## APPLICATION NOTE 946
### 5082-7430 Series Monolithic 7 Segment Displays

The 5082-7430 series solid state displays are common cathode 2 and 3 digit seven segment displays capable of displaying numeric data. These GaAsP displays employ an integral magnification technique to obtain operation at low current low levels.

Display multiplexing concepts are discussed. Several typical drive circuits including an electronic stopwatch, event counter, and electronic calculator are described. Finally, contrast enhancement, mounting, and wavesoldering techniques are discussed.

## APPLICATION NOTE 947
### Digital Data Transmission Using Optically Coupled Isolators

Optically coupled isolators make ideal line receivers for digital data transmission applications. They are especially useful for elimination of common mode interference between two isolated data transmission systems. This application note describes design considerations and circuit techniques with special emphasis on selection of line drivers, transmission lines, and line receiver termination for optimum data rate and common mode rejection. Both resistive and active terminations are described in detail. Specific techniques are described for multiplexing applications, and for common mode rejection and data rate enhancement.

## APPLICATION NOTE 948
### Performance of the 5082-4350/51/60 Series of Isolators in Short to Moderate Length Digital Data Transmission Systems

Describes use of HP 5082-4350/51/60 optically-coupled isolators as a line receiver in a TTL-TTL compatible NRZ (nonreturn-to-zero) data transmission link. It describes several useful total systems including line driver, cable, terminations, and TTL compatible connections.

## APPLICATION NOTE 951-1
### Applications for Low Input Current, High Gain Optically Coupled Isolators

Optically-coupled isolators are useful in line receivers, logic isolation, power lines, medical equipment, and telephone lines. This note discusses use of the 5082-4370 series high CTR isolators in each of these areas.

## Abstracts

### APPLICATION NOTE 951-2
### Linear Applications of Optocouplers

Although optocouplers are not inherently linear, the separate photodiodes used in Hewlett-Packard optocouplers provide better linearity as well as higher speed of response than phototransistor detectors.

Linearity enhancement by use of paired optocouplers is described with specific circuit examples offering DC-to-25 KHz response. These examples illustrate the relative merits of differential and servo techniques.

A circuit with linear AC response to 10 MHz is also described for analog optocouplers having the photodiode terminals externally accessible.

Digital techniques of voltage-to-frequency conversion and pulse width modulation are discussed. Their linearity is quite independent of optocoupler linearity but require use of high speed optocouplers for low distortion.

### APPLICATION NOTE 964
### Contrast Enhancement Techniques

This note discusses the need for contrast improving filters for LED display systems. The characteristics of various commercially available filters are discussed along with a graph demonstrating the effects of these filters on light output from the display. The benefits of circular polarizing and louvered type filters are also covered in detail.

### APPLICATION NOTE 966
### Applications of the HP HDSP-2000 Alphanumeric Display

The HDSP-2000 family of display products provides the designer of Alphanumeric Displays with a variety of easy to use display modules with on board integrated circuits. This application note reviews the theory of operation of the HDSP-2000 family products and details several basic techniques for driving these displays. Thermal management techniques and intensity modulation are also described.

### APPLICATION NOTE 1000
### Digital Data Transmission with the HP Fiber Optic System

Fiber optics can provide solutions to many data transmission system design problems. The purpose of this application note is to aid designers in obtaining optimal benefits from this relatively new technology. Following a brief review of the merits, as well as the limitations, of fiber optics relative to other media, there is a description of the optical, mechanical, and electrical fundamentals of fiber optic data transmission system design. How these fundamentals apply is seen in the detailed description of the Hewlett-Packard system. The remainder of the note deals with techniques recommended for operation and maintenance of the Hewlett-Packard system, with particular attention given to deriving maximum benefit from the unique features it provides.

### APPLICATION NOTE 1001
### Interfacing the HDSP-2000 to Microprocessor Systems

The need for alphanumeric displays has grown very rapidly due to the extensive use of microprocessors in new system design. The presence of the microprocessor in such systems substantially simplifies the traditionally difficult task and is further simplified by using a display element such as the HDSP-2000 which has in one package a four character display, as well as most of the basic electronics necessary to drive the display. This note deals with four different techniques for interfacing the HDSP-2000 display to microprocessor systems.

### APPLICATION NOTE 1002
### Consideration of CTR Variations in Optically Coupled Isolator Circuit Designs

A persistent, and sometimes crucial, concern of designers using optocouplers is that of the current transfer ratio, CTR, changing with time. The change, or CTR degradation, must be accounted for if long, functional lifetime of a system is to be guaranteed. This application note will discuss a number of different sources for this degradation.

### APPLICATION NOTE 1003
### Interfacing 16 Segment Displays to Micro-Processors

The need for alphanumeric displays has grown very rapidly due to the extensive use of microprocessors in new system designs. The HDSP-6508 and HDSP-6300 alphanumeric displays were developed to provide low cost, easy-to-use alternative to 5x7 dot matrix displays. These displays use a 16 segment display font that includes a centered decimal point and colon for increased readability. This font is capable of displaying the 64 character ASCII subset (numbers, punctuation symbols, and upper case alphabet) as well as many special purpose symbols. This application note deals with several techniques to interface the 16 segment display to microprocessor systems.

### APPLICATION NOTE 1004
### Threshold Sensing for Industrial Control Systems with the HCPL-3700 Interface Optocoupler

Interfacing from industrial control systems to logic systems is a necessary operation in order to monitor system progress. This interfacing is found in process control systems, programmable controllers, microprocessor subsystems which monitor limit and proximity switches, environmental sensors and AC line status, in switching power supplies for detection of AC power loss, in power back up systems which need an early warning of power loss in order to save special microprocessor memory information or switch to battery operation, etc. Applications of the HCPL-3700 interface optocoupler are addressed in this note. The isolation and threshold detection capability of the HCPL-3700 allows it to provide unique features which no other optocoupler can provide. Addressed in this note are the advantages of using this optocoupler for isolating systems as well as the device characteristics, DC/AC operational performance with and without filtering, simple calculations for setting desired thresholds, and four typical application examples for the HCPL-3700. Additional coverage is given to protection considerations for the optocoupler from the standpoint of power transients, thermal conditions, and electrical safety requirements of the industrial control environment.

### APPLICATION NOTE 1005
### Operational Considerations for LED Lamps and Display Devices

In the design of a display system, which incorporates LED lamps and display devices, the objective is to achieve an optimum between light output, power dissipation, reliability, and operating life. The performance characteristics and capabilities of each LED device must be known and understood so that an optimum design can be achieved. The primary source for this information is the LED device data sheet. The data sheet typically contains Electrical/Optical Characteristics that list the performance of the device and Absolute Maximum Ratings in conjunction with characteristic curves and other data which describe the capabilities of the device. A thorough understanding of this information and its intended use provides the basis for achieving an optimum design. This application note presents an in-depth discussion of the theory and use of the electrical and optical information contained within a data sheet. Two designs using this information in the form of numerical examples are presented, one for dc operation and one for pulsed (strobed) operation.

### APPLICATION NOTE 1006
### Seven Segment LED Display Applications

This application note begins with a detailed explanation of the two basic product lines that Hewlett-Packard offers in the seven segment display market. This discussion includes mechanical construction techniques, character heights, and typical areas of application. The two major display drive techniques, dc and strobed, are covered. The resultant tradeoffs of cost, power, and ease of use are discussed. This is followed by several typical instrument applications including counters, digital voltmeters, and microprocessor interface applications. Several different microprocessor based drive techniques are presented incorporating both the monolithic and the large seven segment LED displays.

The application note contains a discussion of intensity and color considerations made necessary if the devices are to be end stacked. Hewlett-Packard has made several advances in the area of sunlight viewability of LED displays. The basic theory is discussed and recommendations made for achieving viewability in direct sunlight. Information concerning display mounting, soldering, and cleaning is presented. Finally, an extensive set of tables has been compiled to aid the designer in choosing the correct hardware to match a particular application. These tables include seven segment decoder/drivers, digit drivers, LSI chips designed for use with LEDs, printed circuit board edge connectors, and filtering materials.

# Abstracts

## APPLICATION NOTE 1007
### Bar Graph Array Applications

This application note begins with a description of the manufacturing process used to construct the 10 element array. Next is a discussion of the package design and basic electrical configuration and how they affect designing with the bar graph array. Mechanical information including pin spacing and wave soldering recommendations are made.

Display interface techniques of two basic types are thoroughly discussed. The first of these two drive schemes is applicable in systems requiring display of analog signals in a bar graph format. The second major drive technique interfaces bar graph arrays in systems where the data is of a digital nature. Examples of microprocessor controlled bar graph arrays are presented.

Summarized for the design engineer are tables of available integrated circuits for use with bar graph arrays. Finally, a list of recommended filters is included.

## APPLICATION NOTE 1008
### Optical Sensing with the HEDS-1000

This application note gives the basic optical flux coupling design for discrete emitters and detectors. Presents the concepts of modulation transfer function, depth of field, and reflective sensor design. It also discusses the optical and electrical operation of the HEDS-1000 High Resolution optical sensor. Finally, it presents electrical design techniques which allow the HEDS-1000 to interface with popular logic families.

## APPLICATION NOTE 1009
### Snap-In Fiber Optic Link Application Note

This note describes the theoretical considerations of designing a short distance low cost fiber optic link. Included in the investigation are fiber considerations, emitters, and receiving circuits. A practical solution to achieving low cost and high performance with all plastic, lensed modules with unique snap-in connectors is presented. The dc coupled receiver design allows use in many circuits where asynchronous data is transmitted and the integral shield provides a high degree of immunity to EMI. System flux budgeting calculations bring out link length limitations and several designs are presented for temperature compensation and pulse distortion compensation allowing the recommended link lengths to be tripled. Several applications on interfacing to standard logic families, and standard logic interfaces along with multipoint network configurations point out the usefulness and advantages of the SNAP-IN FIBER OPTIC LINK.

## APPLICATION NOTE 1011
### Design and Operational Considerations for the HEDS-5000 Incremental Shaft Encoder

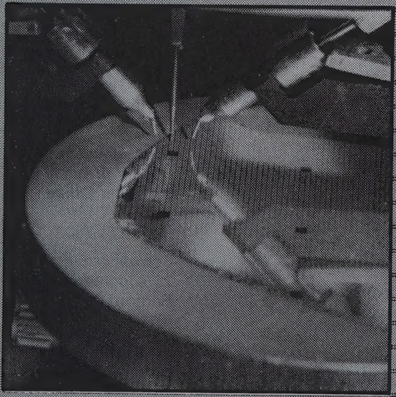
This application note is directed toward the system designer using the HEDS-5000 modular incremental shaft encoder. First the note briefly analyzes the theory of design and operation of the HEDS-5000. A practical approach to design considerations and an error analysis provide an indepth treatment of the relationship between motor mechanical parameters and encoding error accumulation. Several design examples demonstrate the analysis techniques presented. Operation consideratons for assembly, test, trouble shooting and repair are presented. Finally some circuits and software concepts are introduced which will be useful in interfacing the shaft encoder to a digital or microprocessor based system. Appendix A summarizes the uses and advantages of various encoder technologies while Appendix B provides guidance for selecting DC motors suitable for use with the HEDS-5000.

## APPLICATION NOTE 1012
### Methods of Legend Fabrication

Hewlett-Packard LED Light Bar Modules inscribed with fixed messages or symbols can be used as economical annunciators. Annunciators are often used in front panels to convey the status of a system, to indicate a selected mode of operation or to indicate the next step in a sequence. This application note discusses alternative ways the message or symbols (legends) can be designed. A selection matrix is provided to assist in the selection of the most appropriate method of legend fabrication. Each fabrication method is explained in detail along with mounting and attachment techniques. Finally, prevention of cross-talk is discussed for legend areas of a multi-segmented light bar.

# Appendix

- *Hewlett-Packard Components Authorized Distributors and Representatives .............. 420*
- *Hewlett-Packard Sales and Service Offices .............. 423*



# HP Components Authorized Distributor And Representative Directory

FEBRUARY 1982

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## United States

**Alabama**
Hall-Mark Electronics
4900 Bradford Drive
Huntsville 35805
(205) 837-8700

Schweber Electronics
2227 Drake Avenue, S.W.
Suite 14
Huntsville 35805
(205) 882-2200

Hamilton/Avnet
4812 Commercial Drive
Huntsville 35805
(205) 837-7210

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505 South Madison
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4545 Viewridge Avenue
San Diego 92123
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1175 Bordeaux Drive
Sunnyvale 94086
(408) 743-3300

Hamilton Electro Sales
3170 Pullman Street
Costa Mesa 92626
(714) 754-6077

Hamilton Electro Sales
10950 W. Washington Boulevard
Culver City 90230
(213) 558-2121

Schweber Electronics
17811 Gillette Avenue
Irvine 92714
(714) 556-3880

Schweber Electronics
3110 Patrick Henry Drive
Santa Clara 95050
(408) 496-0200

**California** (cont.)
Wyle Distribution Group
124 Maryland Street
El Segundo 90245
(213) 322-8100

Wyle Distribution Group
17872 Cowan Avenue
Irvine 92714
(714) 641-1600

Wyle Distribution Group
9525 Chesapeake Drive
San Diego 92123
(714) 565-9171

Wyle Distribution Group
3000 Bowers Avenue
Santa Clara 95052
(408) 727-2500

**Colorado**
Hamilton/Avnet
8765 East Orchard
Suite 708
Englewood 80111
(303) 740-1000

Wyle Distribution Group
451 E. 124th Avenue
Thornton 80241
(303) 457-9953

**Connecticut**
Hamilton/Avnet
Commerce Drive
Commerce Industrial Park
Danbury 06810
(203) 797-2800

Schweber Electronics
Finance Drive
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Danbury 06810
(203) 792-3500

**Florida**
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1671 W. McNab Road
Ft. Lauderdale 33309
(305) 971-9280

Hall-Mark Electronics
7233 Lake Ellenor Drive
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Kita-Ku, Osaka, 530
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Ryoyo Electric Corporation
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VSI ELECTRONICS LTD.
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Box 32
122 33 Enskede
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**Switzerland**
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CH-8037 Zuerich
(41) 1 429900

Fabrimex
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CH-8032 Zuerich
(41) 1 470670

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Reading, Berkshire
RG3 1ED
(44) 734 585171

Jermyn-Mogul Distribution
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Otford Road
Sevenoaks, Kent
TN14 5EU
(44) 732 50144

Macro Marketing Ltd.
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Slough, Berkshire
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**Yugoslavia**
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Tozd Elzas N. Sol. O.
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61001 Ljubljana
(38) 61 347749
(38) 61 347841

# SALES & SUPPORT OFFICES

## Arranged alphabetically by country

### Product Line Sales/Support Key

| Key | Product Line |
|---|---|
| A | Analytical |
| CM | Components |
| C | Computer Systems Sales only |
| CH | Computer Systems Hardware Sales & Services |
| CS | Computer Systems Software Sales & Services |
| E | Electronic Instruments & Measurement Systems |
| M | Medical Products |
| MP | Medical Products Primary SRO |
| MS | Medical Products Secondary SRO |
| P | Personal Computing Products |
| * | Sales only for specific product line |
| ** | Support only for specific product line |

**IMPORTANT: These symbols designate general product line capability. They do not insure sales or support availability for all products within a line, at all locations. Contact your local sales office for information regarding locations where HP support is available for specific products.**

*HP distributors are printed in italics.*

## ANGOLA

*Telectra*
*Empresa Técnica de Equipamentos*
*Eléctricos, S.A.R.L.*
*R. Barbosa Rodrigues, 41-I DT.*
*Caixa Postal 6487*
***LUANDA***
*Tel: 35515,35516*
*E,M,P*

## ARGENTINA

Hewlett-Packard Argentina S.A.
Avenida Santa Fe 2035
Martinez 1640 **BUENOS AIRES**
Tel: 798-5735, 792-1293
Telex: 122443 AR CIGY
Cable: HEWPACKARG
A,E,CH,CS,P

*Biotron S.A.C.I.y.M*
*Av Paseo Colon 221, 9 Piso*
*1399* ***BUENOS AIRES***
*Tel: 30-4846, 30-1851, 30-8384*
*Telex: 17595 BION/AR*
*M*

*Fate S.A. I.C.I./Electronica*
*Venezuela 1326*
*1095* ***BUENOS AIRES***
*Tel: 379026, 379027*
*Telex: 18137, 22754 ALVAR AR*
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**NEDLANDS**, W.A. 6009
(effective 28 Sept. 1981:
261 Stirling Highway
**CLAREMONT**, W.A. 6010)
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Telex: 93859
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*Olympia (Chile) Ltd.*
*Rodrico de Araya 1045*
*Casilla 256-V*
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*P*

## EL SALVADOR

*IPESA de El Salvador S.A.*
*Boulevard de los Heroes 1148*
***SAN SALVADOR***
*Tel: 252787, 259621*
*Telex: Public Booth 20107*
*A,CH,CM,CS,E,P*

## FINLAND

Hewlett-Packard Oy
Revontulentie 7
SF-02100 **ESPOO** 10
Tel: (90) 455-0211
Telex: 121563 hewpa sf
A,CH,CM,CS,E,MS,P

# SALES & SUPPORT OFFICES

## Arranged alphabetically by country

### FRANCE

Hewlett-Packard France
Le Ligoures
Bureau de Vente de Aix-en-Provence
Place Romée de Villeneuve
F-13090 **AIX-EN-PROVENCE**
Tel: (42) 59-41-02
Telex: 410770F
A,CH,CM,E,MS,P*

Hewlett-Packard France
Boite Postale No. 503
F-25026 **BESANCON**
28 Rue de la Republique
F-25000 **BESANCON**
Tel: (81) 83-16-22
CH,M

Hewlett-Packard France
Bureau de Vente de Lyon
Chemin des Mouilles
Boite Postale No. 162
F-69130 **ECULLY** Cédex
Tel: (78) 33-81-25
Telex: 310617F
A,CH,CM,CS,E,MP

Hewlett-Packard France
Immeuble France Evry
Tour Lorraine
Boulevard de France
F-91035 **EVRY** Cédex
Tel: (60) 77-96-60
Telex: 692315F
CM,E

Hewlett-Packard France
5th Avenue Raymond Chanas
F-38320 **EYBENS**
Tel: (76) 25-81-41
Telex: 980124 HP GRENOB EYBE
CH,CM

Hewlett-Packard France
Bâtiment Ampère
Rue de la Commune de Paris
Boite Postale 300
F-93153 **LE BLANC MESNIL**
Tel: (01) 865-44-52
Telex: 211032F
CH,CM,CS,E,MS

Hewlett-Packard France
Le Montesquieu
Avenue du President JF Kennedy
F-33700 **MERIGNAC**
Tel: (56) 34-00-84
Telex: 550105F
CH,CM,E,MS

Hewlett-Packard France
32 Rue Lothaire
F-57000 **METZ**
Tel: (87) 65-53-50
CH,CM

Hewlett-Packard France
3 Rue Julien Videment
F-44200 **NANTES**
Tel: (40) 48-09-44
CH**

Hewlett-Packard France
Zone Industrielle de Courtaboeuf
Avenue des Tropiques F-91947 Les Ulis Cédex **ORSAY**
Tel: (1) 907-78-25
Telex: 600048F
A,CH,CM,CS,E,MP,P

Hewlett-Packard France
Paris Porte-Maillot 13, 15 25
Boulevard De L'Amiral Bruix
F-75782 **PARIS** Cédex 16
Tel: (01) 502-12-20
Telex: 613663F
CH,CM,MS,P

Hewlett-Packard France
2 Allee de la Bourgonette
F-35100 **RENNES**
Tel: (99) 51-42-44
Telex: 740912F
CH,CM,E,MS,P*

Hewlett-Packard France
98 Avenue de Bretagne
F-76100 **ROUEN**
Tel: (35) 63-57-66 CH**,CS

Hewlett-Packard France
4 Rue Thomas Mann
Boite Postale 56
F-67200 **STRASBOURG**
Tel: (88) 28-56-46
Telex: 890141F
CH,CM,E,MS,P*

Hewlett-Packard France
20 Chemin de la Cépière
F-31081 **TOULOUSE** Cédex
Tel: (61) 40-11-12
Telex: 531639F
A,CH,CM,CS,E,P*

Hewlett-Packard France
Bureau de Vente de Lille
Immeuble Péricentre
Rue Van Gogh
F-59650 **VILLENEUVE D'ASQ**
Tel: (20) 91-41-25
Telex: 160124F
CH,CM,E,MS,P*

### GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Technisches Büro Berlin
Keithstrasse 2-4
D-1000 **BERLIN** 30
Tel: (030) 24-90-86
Telex: 018 3405 hpbln d
A,CH,CM,E,M,P,X

Hewlett-Packard GmbH
Technisches Büro Böblingen
Herrenberger Strasse 110
D-7030 **BÖBLINGEN**
Tel: (07031) 667-1
Telex: 07265739 bbn or 07265743
A,CH,CM,CS,E,MP,P

Hewlett-Packard GmbH
Technisches Büro Dusseldorf
Emanuel-Leutze-Strasse 1
D-4000 **DUSSELDORF**
Tel: (0211) 5971-1
Telex: 085/86 533 hpdd d
A,CH,CM,CS,E,MS,P

Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 **FRANKFURT** 56
Tel: (0611) 50-04-1
Telex: 04 13249 hpffm d
A,CH,CM,CS,E,MP,P

Hewlett-Packard GmbH
Technisches Büro Hamburg
Kapstadtring 5
D-2000 **HAMBURG** 60
Tel: (040) 63804-1
Telex: 21 63 032 hphh d
A,CH,CM,CS,E,MS,P

Hewlett-Packard GmbH
Technisches Büro Hannover
Am Grossmarkt 6
D-3000 **HANNOVER** 91
Tel: (0511) 46-60-01
Telex: 092 3259
A,CH,CM,E,MS,P

Hewlett-Packard GmbH
Technisches Büro Mannheim
Rosslauer Weg 2-4
D-6800 **MANNHEIM**
Tel: (621) 70050
Telex: 0462105
A,C,E

Hewlett-Packard GmbH
Technisches Büro Neu Ulm
Messerschmittstrasse 7
D-7910 **NEU ULM**
Tel: 0731-70241
Telex: 712816 HP ULM-D
A,C,E*

Hewlett-Packard GmbH
Technisches Büro Nürnberg
Neumeyerstrasse 90
D-8500 **NÜRNBERG**
Tel: (0911) 56-30-83
Telex: 0623 860
CH,CM,E,MS,P

Hewlett-Packard GmbH
Technisches Büro München
Eschenstrasse 5
D-8021 **TAUFKIRCHEN**
Tel: (089) 6117-1
Telex: 0524985
A,CH,CM,E,MS,P

### GREAT BRITAIN

Hewlett-Packard Ltd.
Trafalgar House
Navigation Road
**ALTRINCHAM**
Chesire WA14 1NU
Tel: (061) 928-6422
Telex: 668068
A,CH,CS,E,M

Hewlett-Packard Ltd.
Oakfield House, Oakfield Grove
Clifton
**BRISTOL** BS8 2BN
Tel: 36806
Telex: 444302
CH,CM,M,P

Hewlett-Packard Ltd.
14 Wesley Street
**CASTLEFORD**
Yorkshire WF10 1AE
Tel: (0977) 550016
Telex: 5557355
CH

Hewlett-Packard Ltd.
Fourier House
257-263 High Street
**LONDON COLNEY**
Herts., AL2 1HA
Tel: (0727) 24400
Telex: 1-8952716
CH,CS,E

Hewlett-Packard Ltd
Tradax House, St. Mary's Walk
**MAIDENHEAD**
Berkshire, SL6 1ST
Tel: (0628) 39151
CH,CS,E,P

Hewlett-Packard Ltd.
308/314 Kings Road
**READING**, Berkshire
Tel: 61022
Telex: 84-80-68
CM,P

Hewlett-Packard Ltd.
Quadrangle
106-118 Station Road
**REDHILL**, Surrey
Tel: (0737) 68655
Telex: 947234 CH,CS,E

Hewlett-Packard Ltd.
Westminster House
190 Stratford Road
**SHIRLEY**, Solihull
West Midlands B90 3BJ
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Telex: 339105
CH

Hewlett-Packard Ltd.
King Street Lane
**WINNERSH**, Wokingham
Berkshire RG11 5AR
Tel: (0734) 784774
Telex: 847178
A,CS,E,M

### GREECE

*Kostas Karaynnis S.A.*
*8 Omirou Street*
***ATHENS*** *133*
*Tel: 32-30-303, 32-37-371*
*Telex: 21 59 62 RKAR GR*
*A,CH,CM,CS,E,M,P*

*PLAISIO S.A.*
*G. Gerardos*
*24 Stournara Street*
***ATHENS***
*Tel: 36-11-160*
*Telex: 21 9492*
*P*

### GUATEMALA

*IPESA*
*Avenida Reforma 3-48*
***GUATEMALA 9***
*Tel: 316627, 314786*
*Telex: 4192 TELETRO GU*
*A,CH,CM,CS,E,M,P*

### HONG KONG

Hewlett-Packard Hong Kong, Ltd.
G.P.O. Box 795
5th Floor, Sun Hung Kai Centre
30 Harbour Road
**HONG KONG**
Tel: 5-8323211
Telex: 66678 HEWPA HX
Cable: HP ASIA LTD Hong Kong
E,CH,CS,P

*Schmidt & Co. (Hong Kong) Ltd.*
*Wing On Centre, 28th Floor*
*Connaught Road, C.*
***HONG KONG***
*Tel: 5-455644*
*Telex: 74766 SCHMX HX*
*A,M*

### ICELAND

*Elding Trading Company Inc.*
*Hafnarnvoli-Tryggvagotu*
*P.O. Box 895*
***IS-REYKJAVIK***
*Tel: 1-58-20, 1-63-03*
*M*

### INDIA

*Blue Star Ltd.*
*11 Magarath Road*
***BANGALORE*** *560 025*
*Tel: 55668*
*Telex: 0845-430*
*Cable: BLUESTAR*
*A,CH,CM,CS,E*

*Blue Star Ltd.*
*Band Box House*
*Prabhadevi*
***BOMBAY*** *400 025*
*Tel: 422-3101*
*Telex: 011-3751*
*Cable: BLUESTAR*
*A,M*

*Blue Star Ltd.*
*Sahas*
*414/2 Vir Savarkar Marg*
*Prabhadevi*
***BOMBAY*** *400 025*
*Tel: 422-6155*
*Telex: 011-4093*
*Cable: FROSTBLUE*
*A,CH,CM,CS,E,M*

*Blue Star Ltd.*
*Kalyan, 19 Vishwas Colony*
*Alkapuri,* ***BORODA****, 390 005*
*Tel: 65235*
*Cable: BLUE STAR*
*A*

*Blue Star Ltd.*
*7 Hare Street*
***CALCUTTA*** *700 001*
*Tel: 12-01-31*
*Telex: 021-7655*
*Cable: BLUESTAR*
*A,M*

*Blue Star Ltd.*
*133 Kodambakkam High Road*
***MADRAS*** *600 034*
*Tel: 82057*
*Telex: 041-379*
*Cable: BLUESTAR*
*A,M*

*Blue Star Ltd.*
*Bhandari House, 7th/8th Floors*
*91 Nehru Place*
***NEW DELHI*** *110 024*
*Tel: 682547*
*Telex: 031-2463*
*Cable: BLUESTAR*
*A,CH,CM,CS,E,M*

*Blue Star Ltd.*
*15/16:C Wellesley Rd.*
***PUNE*** *411 011*
*Tel: 22775*
*Cable: BLUE STAR*
*A*

*Blue Star Ltd.*
*1-1-117/1 Sarojini Devi Road*
***SECUNDERABAD*** *500 033*
*Tel: 70126*
*Telex: 0155-459*
*Cable: BLUEFROST*
*A,E*

*Blue Star Ltd.*
*T.C. 7/603 Poornima*
*Maruthankuzhi*
***TRIVANDRUM*** *695 013*
*Tel: 65799*
*Telex: 0884-259*
*Cable: BLUESTAR*
*E*

### INDONESIA

*BERCA Indonesia P.T.*
*P.O.Box 496/JKT.*
*Jl. Abdul Muis 62*
***JAKARTA***
*Tel: 373009*
*Telex: 46748 BERSAL IA*
*Cable: BERSAL JAKARTA*
*P*

*BERCA Indonesia P.T.*
*Wisma Antara Bldg., 17th floor*
***JAKARTA***
*A,CS,E,M*

*BERCA Indonesia P.T.*
*P.O. Box 174/SBY.*
*Jl. Kutei No. 11*
***SURABAYA***
*Tel: 68172*
*Telex: 31146 BERSAL SB*
*Cable: BERSAL-SURABAYA*
*A*,E,M,P*

## IRAQ

Hewlett-Packard Trading S.A.
Mansoor City 9B/3/7
**BAGHDAD**
Tel: 551-49-73
Telex: 2455 HEPAIRAQ IK
CH,CS

## IRELAND

Hewlett-Packard Ireland Ltd.
Kestrel House
Clanwilliam Court
Lower Mount Street
**DUBLIN** 2, Eire
Tel: 680424, 680426
Telex: 30439
A,CH,CM,CS,E,M,P

*Cardiac Services Ltd.*
*Kilmore Road*
*Artane*
***DUBLIN** 5, Eire*
*Tel: (01) 351820*
*Telex: 30439*
*M*

## ISRAEL

*Electronics Engineering Division*
*Motorola Israel Ltd.*
*16 Kremenetski Street*
*P.O. Box 25016*
***TEL-AVIV 67899***
*Tel: 3-338973*
*Telex: 33569 Motil IL*
*Cable: BASTEL Tel-Aviv*
*A,CH,CM,CS,E,M,P*

## ITALY

Hewlett-Packard Italiana S.p.A.
Traversa 99C
Giulio Petrone, 19
I-70124 **BARI**
Tel: (080) 41-07-44
M

Hewlett-Packard Italiana S.p.A.
Via Martin Luther King, 38/111
I-40132 **BOLOGNA**
Tel: (051) 402394
Telex: 511630
CH,CM,E,MS

Hewlett-Packard Italiana S.p.A.
Via Principe Nicola 43G/C
I-95126 **CATANIA**
Tel: (095) 37-10-87
Telex: 970291 C,P

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL NAVLIGLIO**
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Telex: 334632
A,CH,CM,CS,E,MP,P

Hewlett-Packard Italiana S.p.A.
Via Nuova san Rocco A
Capodimonte, 62/A
I-80131 **NAPOLI**
Tel: (081) 7413544
A,CH,CM,E

Hewlett-Packard Italiana S.p.A.
Viale G. Modugno 33
I-16156 **GENOVA PEGLI**
Tel: (010) 68-37-07 E,C

Hewlett-Packard Italiana S.p.A.
Via Turazza 14
I-35100 **PADOVA**
Tel: (49) 664888
Telex: 430315
A,CH,CM,E,MS

Hewlett-Packard Italiana S.p.A.
Viale C. Pavese 340
I-00144 **ROMA**
Tel: (06) 54831
Telex: 610514
A,CH,CM,CS,E,MS,P*

Hewlett-Packard Italiana S.p.A.
Corso Giovanni Lanza 94
I-10133 **TORINO**
Tel: (011) 682245, 659308
Telex: 221079
CH,CM,E

## JAPAN

Yokogawa-Hewlett-Packard Ltd.
Inoue Building
1-1348-3, Asahi-cho
**ATSUGI**, Kanagawa 243
Tel: (0462) 24-0451
CM,C*,E

Yokogawa-Hewlett-Packard Ltd.
Sannomiya-Daiichi Seimei-Bldg. 5F
69 Kyo-machi Chuo-ku
**KOBE** 650
Tel: (078) 392-4791
C,E

Yokogawa-Hewlett-Packard Ltd.
Kumagaya Asahi Yasoji Bldg 4F
3-4 Chome Tsukuba
**KUMAGAYA**, Saitama 360
Tel: (0485) 24-6563
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Building
1-4-73, San-no-maru
**MITO**, Ibaragi 310
Tel: (0292) 25-7470
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Sumitomo Seimei Nagoya Bldg.
11-2 Shimo-sasajima-cho
Nakamura-ku
**NAGOYA**, Aichi 450
Tel: (052) 571-5171
CH,CM,CS,E,MS

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg., 4th Floor
5-4-20 Nishinakajima, 5-chome
Yodogawa-ku
**OSAKA**, 532
Tel: (06) 304-6021
Telex: YHPOSA 523-3624
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
3-29-21 Takaido-Higashi 3-chome
Suginami-ku
**TOKYO** 168
Tel: (03) 331-6111
Telex: 232-2024 YHPTOK
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
3-30-4 Tsuruya-cho
Kanagawa-ku,
**YOKOHAMA** Kanagawa, 221
Tel: (045) 312-1252
CH,CM,E

## JORDAN

*Mouasher Cousins Company*
*P.O. Box 1387*
***AMMAN***
*Tel: 24907, 39907*
*Telex: 21456 SABCO JO*
*CH,E,M,P*

## KENYA

*ADCOM Ltd., Inc.*
*City House, Wabera Street*
*P.O.Box 30635*
***NAIROBI***
*Tel: 331955*
*Telex: 22639*
*E,M*

## KOREA

*Samsung Electronics*
*Industrial Products Div.*
*76-561 Yeoksam-Dong*
*Kangnam-Ku*
*C.P.O. Box 2775*
***SEOUL***
*Tel: 555-7555, 555-5447*
*Telex: K27364 SAMSAN*
*A,CH,CM,CS,E,M,P*

## KUWAIT

*Al-Khalidya Trading & Contracting*
*P.O. Box 830 Safat*
***KUWAIT***
*Tel: 42-4910, 41-1726*
*Telex: 2481 Areeg kt*
*CH,E,M*

*Photo & Cine Equipment*
*P.O. Box 270 Safat*
***KUWAIT***
*Tel: 42-2846, 42-3801*
*Telex: 2247 Matin*
*P*

## LEBANON

*G.M. Dolmadjian*
*Achrafieh*
*P.O. Box 165.167*
***BEIRUT***
*Tel: 290293*
*MP*

## LUXEMBOURG

Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 ***BRUSSELS***
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,CH,CM,CS,E,MP,P

## MALAYSIA

Hewlett-Packard Sales (Malaysia)
Sdn. Bhd.
Suite 2.21/2.22
Bangunan Angkasa Raya
Jalan Ampang
**KUALA LUMPUR**
Tel: 483544
Telex: MA31011
A,CH,E,M,P*

*Protel Engineering*
*Lot 319, Satok Road*
*P.O.Box 1917*
*Kuching, **SARAWAK***
*Tel: 53544*
*Telex: MA 70904 PROMAL*
*Cable: PROTELENG*
*A,E,M*

## MALTA

*Philip Toledo Ltd.*
*Natabile Rd.*
***MRIEHEL***
*Tel: 447 47, 455 66*
*Telex: MW.649*
*P*

## MEXICO

Hewlett-Packard Mexicana, S.A. de C.V.
Avenida Periferico Sur No. 6501
Tepepan, Xochimilco
**MEXICO CITY 23, D.F.**
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Telex: 017-74-507
A,CH,CS,E,MS,P

Hewlett-Packard Mexicana, S.A. de C.V.
Rio Volga 600
Colonia del Valle
**MONTERREY**, N.L.
Tel: 78-42-93, 78-42-40, 78-42-41
Telex: 038-410
CH

## MOROCCO

*Dolbeau*
*81 rue Karatchi*
***CASABLANCA***
*Tel: 3041-82, 3068-38*
*Telex: 23051, 22822*
*E*

*Gerep*
*2 rue d'Agadir*
*Boite Postale 156*
***CASABLANCA***
*Tel: 272093, 272095*
*Telex: 23 739*
*P*

## NETHERLANDS

Hewlett-Packard Nederland B.V.
Van Heuven Goedhartlaan 121
NL 1181KK **AMSTELVEEN**
P.O. Box 667
NL1080 AR **AMSTELVEEN**
Tel: (20) 47-20-21
Telex: 13 216
A,CH,CM,CS,E,MP,P

Hewlett-Packard Nederland B.V.
Bongerd 2
NL 2906VK **CAPPELLE**, A/D Ijessel
P.O. Box 41
NL2900 AA **CAPELLE**, Ijssel
Tel: (10) 51-64-44
Telex: 21261 HEPAC NL
A,CH,CM,CS

Koning en Hartman Electrotechnick B.V.
Koperwerf 30
2544 En den Haag
The **NETHERLANDS**
Tel: 070-210101
Telex: 31528
CM

## NEW ZEALAND

Hewlett-Packard (N.Z.) Ltd.
169 Manukau Road
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Epsom, **AUCKLAND**
Tel: 687-159
Cable: HEWPACK Auckland
CH,CM,E,P*

Hewlett-Packard (N.Z.) Ltd.
4-12 Cruickshank Street
Kilbirnie, **WELLINGTON 3**
P.O. Box 9443
Courtenay Place, WELLINGTON
Tel: 877-199
Cable: HEWPACK Wellington
CH,CM,E,P

*Northrop Instruments & Systems Ltd.*
*369 Khyber Pass Road*
*P.O. Box 8602*
***AUCKLAND***
*Tel: 794-091*
*Telex: 60605*
*A,M*

*Northrop Instruments & Systems Ltd.*
*110 Mandeville St.*
*P.O. Box 8388*
***CHRISTCHURCH***
*Tel: 486-928*
*Telex: 4203*
*A,M*

*Northrop Instruments & Systems Ltd.*
*Sturdee House*
*85-87 Ghuznee Street*
*P.O. Box 2406*
***WELLINGTON***
*Tel: 850-091*
*Telex: NZ 3380*
*A,M*

## NORTHERN IRELAND

*Cardiac Services Company*
*95A Finaghy Road South*
***BELFAST** BT 10 OBY*
*Tel: (0232) 625-566*
*Telex: 747626*
*M*

## NORWAY

Hewlett-Packard Norge A/S
Folke Bernadottesvei 50
P.O. Box 3558
N-5033 **FYLLINGSDALEN** (BERGEN)
Tel: (05) 16-55-40
Telex: 16621 hpnas n
CH,CM,E

Hewlett-Packard Norge A/S
Oesterndalen 18
P.O. Box 34
N-1345 **OESTERAAS**
Tel: (02) 17-11-80
Telex: 16621 hpnas n
A*,CH,CM,E,MS,P

## OMAN

*Khimjl Ramdas*
*P.O. Box 19*
***MUSCAT***
*Tel: 72-22-17, 72-22-25*
*Telex: 3289 BROKER MB MUSCAT*
*P*

## PAKISTAN

*Mushko & Company Ltd.*
*10, Bazar Road*
*Sector G-6/4*
***ISLAMABAD***
*Tel: 26875*
*Cable: FEMUS Rawalpindi*
*A,E,M*

*Mushko & Company Ltd.*
*Oosman Chambers*
*Abdullah Haroon Road*
***KARACHI** 0302*
*Tel: 511027, 512927*
*Telex: 2894 MUSKO PK*
*Cable: COOPERATOR Karachi*
*A,E,M,P*

## PANAMA

*Electrónico Balboa, S.A.*
*Calle Samuel Lewis*
*Apartado 4929*
*Panama 5*
*Edificio "Alfa" No. 2*
***CIUDAD DE PANAMA***
*Tel: 64-2700*
*Telex: 0383 ELECTRON PG*
*A,CM,E,M,P*

# SALES & SUPPORT OFFICES
## Arranged alphabetically by country

### PANAMA (Con't.)
*Foto Internacional, S.A.*
*Free Zone Colon*
*Apartado 2068*
***COLON 3***
*Tel: 45-2333*
*Telex: 379 8626, 386 8722*
*P*

### PERU
*Cía Electro Médica S.A.*
*Los Flamencos 145, San Isidro*
*Casilla 1030*
***LIMA 1***
*Tel: 41-4325, 41-3703*
*Telex: Pub. Booth 25306*
*A,CM,E,M,P*

### PHILIPPINES
*The Online Advanced Systems Corporation*
*Rico House, Amorsolo Cor. Herrera Street*
*Legaspi Village, Makati*
*P.O. Box 1510*
*Metro **MANILA***
*Tel: 85-35-81, 85-34-91, 85-32-21*
*Telex: 3274 ONLINE*
*A,CH,CS,E,M*

*Electronic Specialists and Proponents Inc.*
*690-B Epifanio de los Santos Avenue*
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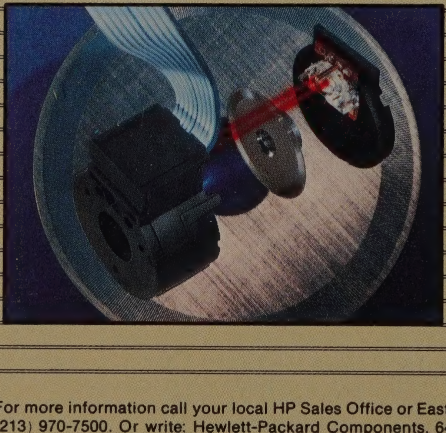

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